9

elektor

up-to-date electronics for lab and leisure

D 71683

98

June 1983

85 p.
IR 123 p. (incl. VAT)
$ 2.75

$2.30

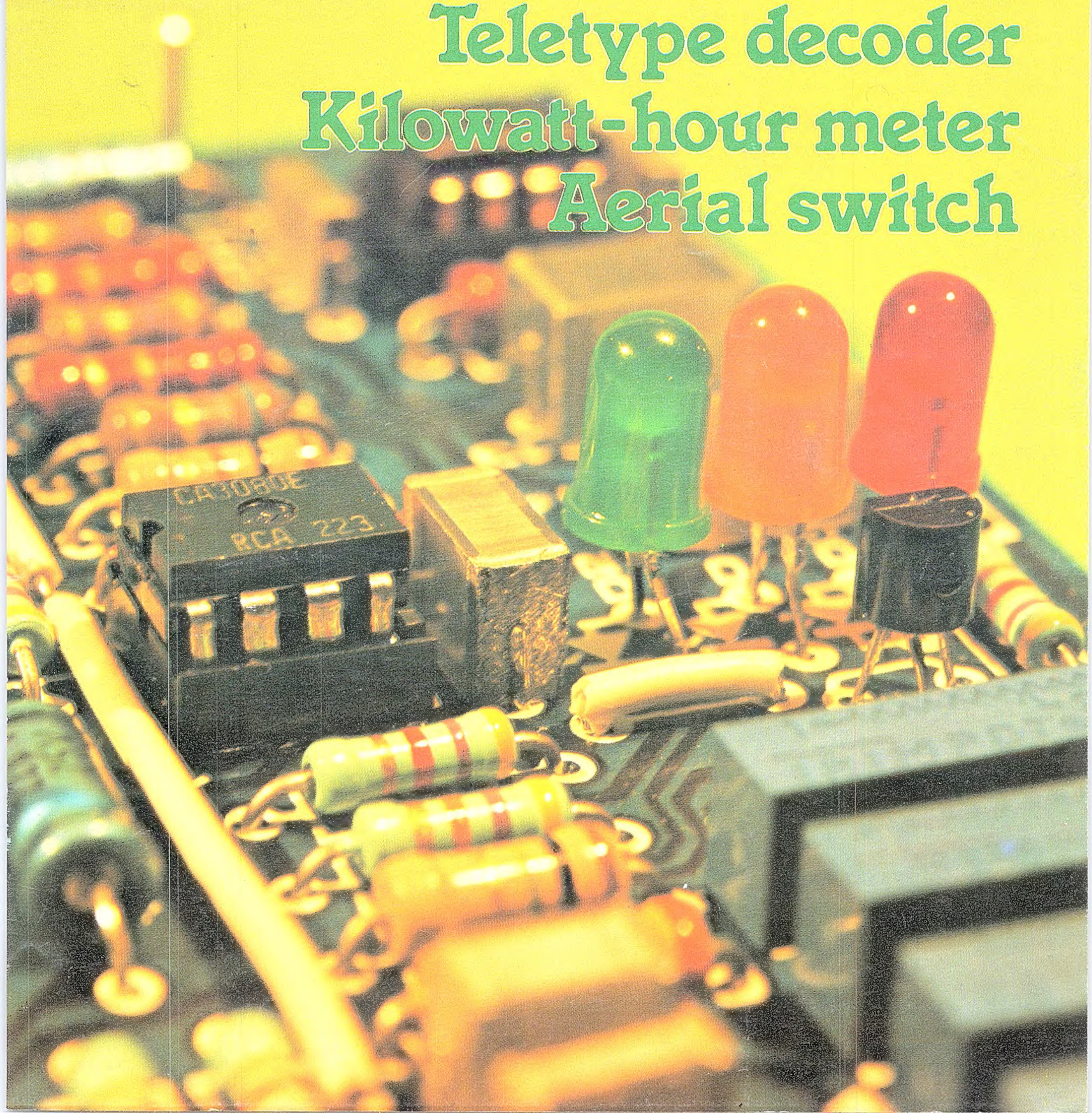
Spectrum Display

the ultimate Hi-Fi accessory!

Teletype decoder

Kilowatt-hour meter

Aerial switch



TTLs

7400	11p
7401	11p
7402	11p
7403	12p
7404	12p
7405	15p
7406	18p
7407	18p
7408	14p
7409	14p
7410	14p
7411	16p
7412	14p
7413	16p
7414	18p
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7417	18p
7420	14p
7421	18p
7422	20p
7423	18p
7425	18p
7426	18p
7427	18p
7428	18p
7430	14p
7432	18p
7433	22p
7437	22p
7438	22p
7439	25p
7440	15p
7441	55p
7442A	30p
7443	70p
7444	70p
7445	50p
7446A	50p
7447A	36p
7448	45p
7450	15p
7451	15p
7453	15p
7454	15p
7460	15p
7470	30p
7472	25p
7473	25p
7474	18p
7475	22p
7476	25p
7480	48p
7481	120p
7482	65p
7483A	38p
7484	65p
7485	60p
7486	18p
7489	170p
7490A	20p
7491	35p
7492A	25p
7493A	24p
7494	35p
7495A	35p
7496	35p
7497	90p
74100	80p
74104	50p
74105	55p
74107	22p
74109	25p
74110	30p
74111	55p
74112	170p
74116	50p
74118	55p
74119	60p
74120	60p
74121	25p
74122	30p
74123	36p
74125	30p
74126	30p
74128	36p
74132	30p
74136	28p
74141	55p
74142	175p
74143	200p
74144	200p
74145	40p
74147	75p
74148	60p
74150	50p
74151A	36p
74153	36p
74154	50p
74155	40p
74156	36p
74157	30p
74159	75p
74160	40p
74161	40p
74162	40p
74163	40p
74164	45p
74165	45p
74166	48p
74167	150p
74170	120p
74172	250p
74173	50p
74174	55p
74175	50p
74176	40p
74177	45p
74178	70p
74180	40p
74181	115p
74182	40p
74184	90p
74185A	90p
74186	470p
74188	250p
74190	45p
74191	45p
74192	45p
74193	45p
74194	40p
74195	40p
74196	40p
74197	40p
74198	80p
74199	80p
74221	55p
74251	45p
74259	100p
74265	45p
74278	140p
74279	40p
74283	50p
74284	160p
74285	160p
74290	75p
74293	80p
74298	100p
74365A	30p
74366A	30p
74367A	30p
74368A	30p
74390	75p
74393	90p
74490	95p

74LS SERIES

74LS00	11p
74LS02	11p
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74LS04	12p
74LS05	12p
74LS08	12p
74LS09	12p
74LS10	13p
74LS11	13p
74LS12	13p
74LS13	20p
74LS14	25p
74LS15	12p
74LS20	13p
74LS21	13p
74LS27	13p
74LS30	13p
74LS32	13p
74LS33	14p
74LS37	14p
74LS38	14p
74LS42	30p
74LS47	36p
74LS51	14p
74LS55	15p
74LS73	18p
74LS74	16p
74LS75	18p
74LS76	18p
74LS83	38p
74LS85	40p
74LS86	16p
74LS90	22p
74LS92	30p
74LS93	22p
74LS96	50p
74LS107	20p
74LS109	27p
74LS112	20p
74LS113	20p
74LS114	22p
74LS122	25p
74LS123	34p
74LS124	90p
74LS125A	24p
74LS126A	25p
74LS132	34p
74LS133	25p
74LS136	25p
74LS138	27p
74LS139	27p
74LS145	70p
74LS147	100p
74LS148	75p
74LS151	40p
74LS153	40p
74LS154	80p
74LS155	30p
74LS156	36p
74LS157	27p
74LS158	30p
74LS160A	36p
74LS161A	36p
74LS162A	36p
74LS163A	36p
74LS164	40p
74LS165A	50p
74LS166A	55p
74LS170	70p
74LS173A	55p
74LS174	40p
74LS175	40p
74LS181	90p
74LS190	36p
74LS191	36p
74LS192	36p
74LS193	36p
74LS194A	35p
74LS195A	35p
74LS196	45p
74LS197	45p
74LS221	50p
74LS240	55p
74LS241	55p
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74LS245	75p
74LS247	70p
74LS248	55p
74LS249	55p
74LS251	30p
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74LS266	20p
74LS273	55p
74LS279	30p
74LS283	40p
74LS293	40p
74LS299	150p
74LS321	150p
74LS323	160p
74LS324	150p
74LS348	90p
74LS352	60p
74LS353	60p
74LS363	140p
74LS364	140p
74LS365A	30p
74LS367A	30p
74LS368A	30p
74LS373	55p
74LS374	55p
74LS375	45p
74LS377	70p
74LS378	70p
74LS390	45p
74LS393	45p
74LS399	160p
74LS445	100p
74LS540	90p
74LS541	80p
74LS610	£19
74LS612	£19
74LS626	150p
74LS628	150p
74LS640	100p
74LS641	100p
74LS642	100p
74LS643	100p
74LS644	100p
74LS668	100p
74LS669	100p
74LS670	120p
74LS682	300p
74LS684	300p
74LS687	£400p

74C SERIES

74C244	160p
74C245	180p
74C373	160p
74C374	160p

4000 CMOS

4000	10p
4001	10p
4002	12p
4006	50p
4007	14p
4008	36p
4009	24p
4010	24p
4011	11p
4012	16p
4013	20p
4014	48p
4015	40p
4016	20p
4017	32p
4018	45p
4019	25p
4020	48p
4021	40p
4022	45p
4023	13p
4024	32p
4025	13p
4026	80p
4027	20p
4028	40p
4029	45p
4030	15p
4031	125p
4033	125p
4034	140p
4035	45p
4036	275p
4037	110p
4038	110p
4039	290p
4040	40p
4041	40p
4042	40p
4043	40p
4044	40p
4045	105p
4046	50p
4047	45p
4048	50p
4049	24p
4050	24p
4051	45p
4052	60p
4053	50p
4054	90p
4055	90p
4056	90p
4059	450p
4060	55p
4063	90p
4066	27p
4067	225p
4068	14p
4069	14p
4070	14p
4071	14p
4072	14p
4073	14p
4075	14p
4076	48p
4077	16p
4081	14p
4082	15p
4086	40p
4089	125p
4093	24p
4094	90p
4095	75p
4096	70p
4097	290p
4098	90p
4099	100p
40100	200p
40101	130p
40102	140p
40103	170p
40104	90p
40105	110p
40106	36p
40107	60p
40108	450p
40109	100p
40110	275p
40114	225p
40244	160p
40245	180p
40257	160p
4502	60p
4503	45p
4507	35p
4508	130p
4510	45p
4511	45p
4512	48p
4514	110p
4515	110p
4516	55p
4518	40p
4519	30p
4520	50p
4521	90p
4526	60p
4527	60p
4528	50p
4531	125p
4532	70p
4534	400p
4536	270p
4538	90p
4539	70p
4541	70p
4543	75p
4553	245p
4555	35p
4556	35p
4557	300p
4560	120p
4566	160p
4568	250p
4569	170p
4572	30p
4583	90p
4584	36p
4585	75p
4599	290p
4724	150p
40014	40p
40085	90p
40097	45p
14411	675p
14412	800p
14433	1100p
14495	300p
14500	575p
14599	290p
CD22100	350p
CD22101	700p
CD22102	700p

COUNTERS

74C925	400p
74C926	£5
74C928	600p
ICM7216B	2000p
ICM7217A	850p
MK50398N	750p
ZN1040E	670p

TTL & ECL

10116	70p
10231	350p

LINEAR I.Cs

AD7581	£14
AY1 5050	99p
AY3 8910	350p
AY3 8912	625p
AY5 4007D	600p
CA3019	80p
CA3028A	120p
CA3046	70p
CA3080E	70p
CA3086	48p
CA3089E	200p
CA3090AQ	400p
CA3130E	90p
CA3140E	40p
CA3160E	100p
CA3161E	150p
CA3162E	450p
CA3189E	300p
D7002C	420p
DAC0800	£2
DAC0808	£2
HA1388	250p
ICL7106	700p
ICL8038	300p
LF351	48p
LF356P	95p
LM10C	325p
LM301A	25p
LM308N	75p
LM310	120p
LM311	70p
LM318	150p
LM319	215p
LM324	30p
LM339	50p
LM348	65p
LM358P	60p
LM377	175p
LM380	75p
LM381AN	180p
LM386	90p
LM387	120p
LM389	95p
LM393	100p
LM394CH	300p
LM709	36p
LM710	50p
LM711	70p
LM733	60p
LM741	18p
LM747	70p
LM748	35p
LM1011	480p
LM1886	£5
LM1889	350p
LM2917	200p
LM3900	50p
LM3909	85p
LM3911	125p
LM3914	200p
LM3915	200p
LM3916	225p
LM13600	110p
MB3712	200p
MC1310P	150p
MC1458	36p
MC1495L	350p
MC1496	70p
MC3340P	120p
MC3401	50p
MC3403	65p
MF10CN	250p
MK50398	750p
MK50240	£9
ML920	800p
MM57160	620p
NE531	140p
NE555	16p
NE556	45p
NE564	420p
NE565	120p
NE566	155p
NE567	140p
NE571	400p
NE5534A	250p
RC4136	60p
S566B	225p
SAA 1900	£16
SAD1024A	900p
SPO256AL2	£12
SL 490	350p
SN76477	450p
TA7205	90p
TAA550	50p
TAA621	275p
TBA6418X1	400p
TBA800	80p
TBA810	100p
TBA820	80p
TBA950	225p
TC9109	750p
TCA210	350p
TCA220	350p
TCA440	220p
TCA940	175p
TDA1004A	300p
TDA1008	320p
TDA1010	200p
TDA1022	500p
TDA1024	120p
TDA1034B	250p
TDA1170	300p
TDA2002V	300p
TDA2020	320p
TLO71/81	25p
TLO72/82	45p
TLO74	100p
TLO83	75p
TLO84	90p
TLO94	200p
TL170	50p
TMS1601	£12
UAA170	170p
ULN2003	108p
XR210	400p
XR2206	300p
ZN414	95p
ZN419C	190p
ZN424E	130p
ZN425E	340p
ZN426E	300p
ZN427E	590p
ZN428E	400p
ZN429E	210p
ZN450E	790p
ZN459	600p
ZN1034E	200p
ZN1040E	670p
ZNA234	850p
ZNA134	£23

VOLTAGE REGULATORS
Fixed Plastic TO-220

1A	+ve		−ve	
5v	7805	40p	7905	45p
6v	7806	40p	7906	45p
8v	7808	40p	7908	45p
12v	7812	40p	7912	45p
15v	7815	40p	7915	45p
18v	7818	40p	7918	45p
24v	7824	40p	7924	45p
100mA	+ve		TO-92	
5v	78L05	30p	79L05	50p
12v	78L12	30p	79L12	50p
15v	78L15	50p	79L15	50p

OTHER REGULATORS

LM309K	140p	LM350T	350p
LM317T	100p	78MGT2C	140p
LM323K	450p	79GUIC	225p
LM723	30p	79HGKC	650p
78GUIC	200p	78PO5	900p
78HO5	550p	RC4195NB	150p
78HGKC	600p	TL494/7	300p

OPTO-ELECTRONICS

2N5777	40p	ORP60	120p
OCP71	250p	ORP61	120p
ORP12	90p	TIL78	55p
TIL32	55p		

OPTO-ISOLATORS

ILD74	130p	TIL111	70p
MCT6	160p	TIL112	70p
MOC3020	150p	TIL 113	70p
MSC2400	190p	TIL116	70p

LEDS

0.125"		0.2"	
TIL220 Red	10p	TIL209 Red	10p
TIL222 Gr	12p	TIL212 Ye	15p
TIL228 Ye	15p	TIL211 Gr	12p
Rectangular		LEDS (R, G, Y)	30p

DISPLAYS

DL 704	140p	NSB5881	570p
DL 707 Red	140p	TIL311	600p
DL 707 Gr	140p	TIL312/3	110p
DL 747 Red	225p	TIL321/2	130p
DL 747 Gr	225p	TIL330	140p
FND357	120p	7750/60	200p
FND500	90p	BARGRAPH	225p
FND507	90p	**DRIVERS**	
MAN3640	200p	9368	250p
MAN4640	200p	9370	300p
MAN6610	200p	UDN6118	320p
		UDN6184	320p

★ SPÉCIAL OFFER ★

2114L	80p	4116–2	80p
2716 (+5V)	250p	4164–2	450p
2532	350p	6116P–3	350p

CPU's

1802CE	650p
2650A	1200p
6502	350p
6800	225p
6802	250p
6809	650p
INS8060	1100p
8080A	250p
8085A	450p
8088	£18
Z80	290p
Z80A	320p
Z80B	£9
TMS995	£12

SUPPORT DEVICES

3242	800p
6522	350p
6532	550p
6551	650p
6821	100p
6850	110p
6852	250p
8205	225p
8212	110p
8216	100p
8224	200p
8228	270p
8251	250p
8253	390p
8255	250p
8257	400p
8259	400p
8271	£36
8279	440p
Z80P10	250p
Z80AP10	280p
Z80CTC	250p
Z80SIO 1/2/3	£9

MEMORIES

2101 4L	400p
2102 2L	120p
2107B	500p
2111 4L	300p
2112	300p
2114L	90p
2114L 2	95p
2147	400p
4027	300p
4116L 2	90p
4118	400p
4164	400p
4816AP 3	280p
5101L	300p
6116P 3	420p
6116LP 3	550p
6514	200p
6810	120p

PROMS

71301	700p
74S188	275p
74S201	350p
74S287	350p
74S387	350p
74S470	600p
74S471	600p
74S571	650p
74S573	900p
82S123	300p
82S137	750p
93427	400p
93436	650p
93446	650p
93448	900p

BAUD RATE GENERATOR

COM8116	700p
MC14411	675p

EPROMS

2516	250p
2564	800p
2708	250p
2716	250p
2532	375p
2732	375p
2716(300nS)	500p
2732(300nS)	£4
2764	£11

MODULATORS

6MHz UHF	375p
8MHz UHF	450p

UARTS

AY 5 1013P	300p
AY 5 1015P	300p
IM6402	360p
TR1602	300p
COM 8017	300p

CRT CONTROLLER

CRT 5027	£18
CRT 5037	£18
CRT 6545	900p
MC6845	650p
MC6847	£10
SFF96364	£8
EF 9365	£36
EF 9366	£36
TMS9927	£18
TMS9928	£20
TM S9929	£20

CHARACTER GEN.

RO-3-2513U.C.	750p
RO-3-2513L.C.	700p
SN74S262AN	£10

CRYSTALS

100KHz	250p
200KHz	280p
1MHz	290p
1.008MHz	275p
1.843MHz	210p
1.89MHz	300p
2.0MHz	225p
2.457MHz	210p
3.276MHz	150p
3.57945MHz	100p
4.0MHz	150p
4.19MHz	200p
4.43MHz	110p
5.068MHz	200p
6.0MHz	150p
7.0MHz	150p
8.0MHz	175p
8.867MHz	175p
10.7MHz	150p
15.0MHz	200p
17.7MHz	200p
18MHz	200p
24.00 MHz	200p
26.690MHz	150p
27.145MHz	200p

KEYBOARD ENCODER

AY-5-2376	700p
74C 922N	420p

TELETEXT DECODER

SAA5020	£6
SAA5030	£9
SAA5041	£16
SAA5050	£9
EF9340	700p
EF9341	700p

INTERFACE ICS

AD558	775p
AD561J	£20
AD7581	1250p
DM8131	275p
DP8304	250p
DS3691	300p
DS8835	200p
DS8836	150p
DS8838	225p
MC1488	55p
MC1489	55p
MC3446	250p
MC3480	850p
MC3486	500p
MC3487	300p
75107	90p
75110	90p
75150P	120p
75154	140p
75182	90p
75365	150p
75451/2	72p
75491/2	65p
81LS95/96	80p
81LS97/98	80p
81LS120	250p
8T26	120p
8T28	120p
8T95/96	90p
8T97/98	90p
9601	220p
9602	220p
9637AP	160p
ZN425E-8	350p
ZN426E-8	350p
ZN427E-8	600p
ZN428E-8	450p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	22p	40 pin	30p

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

JUMPER LEADS

24" Ribbon cable with DIP Headers

	14 pin	16 pin	24 pin	40 pin
Single End	145p	165p	240p	380p
Double End	210p	230p	345p	540p

24" Ribbon cable with sockets

	20 pin	26 pin	34 pin	40 pin
Single End	160p	200p	280p	300p
Double End	290p	370p	480p	525p

24" Ribbon cable with edge conn.

	20 way	34 way	40 way	50 way
Single End	275p	525p	600p	650p

24" Cable with 25 way D Connector
Male 500p Female 540p

EURO CONNECTORS

	Plug	Socket
DIN 41612 2 × 32-way	300p	350p
angled 2 × 32-way	350p	400p
angled 3 × 32-way	400p	—
(for 2 × 32 way specify a + b or a + c)		
DIN 41617 21-way	160p	165p
DIN 41617 31-way	170p	170p
DIN 4161Z		
2-32 way St. Pin	220p	275p
2-32 way Ang. Pin	275p	320p
3-32 way St. Pin	260p	300p
3-32 way Ang. Pin	375p	350p

IDC CONNECTORS

	10 way	20 way	26 way	34 way	40 way	50 way
Header Plug	90p	145p	175p	200p	220p	235p
Receptacle	85p	125p	150p	160p	190p	200p
Edge Conn.	120p	195p	240p	320p	340p	390p

MIN. D CONNECTORS

	9 way	15 way	25 way	37 way
MALE				
solder	80p	105p	160p	250p
angled	150p	210p	250p	365p
FEMALE				
solder	105p	160p	200p	335p
angled	165p	215p	290p	440p
hood (top/side entry)	90p	85p	90p	100p

25 way Centronix Type Conn.	£6.50
37 way Centronix Type conn.	£6.50

IDC 25 way plug 385p Socket 450p

TRANSISTORS

BC107/8	14p	BC548C	9p	MJ2955	90p	2N2219A	25p
BC108/9	15p	BC549C	12p	MJ3001	225p	2N2222A	25p
BC109/C	16p	BC557B	12p	MJE2955	130p	2N2484	25p
BC140	30p	BC558B	12p	MJE3055	70p	2N2646	45p
BC141	30p	BC559C	16p	MPF102	30p	2N2905A	25p
BC160	30p	BCY71/2	20p	MPF103/4	30p	2N3053	25p
BC161	30p	BD131	60p	MPF105	30p	2N3054	55p
BC177	16p	BD132	80p	MPSA12	30p	2N3055	35p
BC179C	18p	BD135	40p	TIP29C	40p	2N3442	140p
BC182/L	10p	BD136	35p	TIP31B	40p	2N3702/3	10p
BC183/L	10p	BD139	40p	TIP31C	50p	2N3704/5	10p
BC184/L	10p	BD241B	75p	TIP32A/C	75p	2N3773	200p
BC212/L	12p	BD242B	75p	TIP32C	50p	2N3819	20p
BC213/L	11p	BF244B	25p	TIP33C	70p	2N3820	40p
BC214/L	10p	BF256B	45p	TIP35C	150p	2N3866	90p
BC327	10p	BF257/8	30p	TIP36C	160p	2N3904/6	15p
BC337	10p	BF259	35p	TIP41C	55p	2N4871	50p
BC338	15p	BF337	30p	TIP42A	50p	2N5245	40p
BC477	30p	BFR80/81	25p	TIP42C	60p	2N5457/8	30p
BC516/7	36p	BFY50/51	24p	TIP47	90p	2N5459	30p
BC547B	12p	BFY52	24p	TIP54	160p	2N6027	30p
		BFY90	75p	TIP2955	60p	3N128	120p
		MJ2501	225p	TIP3055	60p	3N140/1	120p
				2N2160	295p	40673	75p
						40871/2	100p

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IN4006/7	7p
IN5401/3	14p
IN5404/7	19p
IS920	9p

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1A100V	20p
1A600V	30p
2A50V	30p
2A100V	35p
2A400V	45p
3A200V	60p
4A100V	95p
4A400V	100p
6A50V	80p
6A100V	100p
6A400V	120p
8A100V	150p
10A100V	180p
10A400V	200p

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elektor infocard 84

Standards 12

Telegraphy Codes

		CCITT nr. 2					CCITT Rec. 342							CCITT Rec. 476								
A	–	1	1	0	0	0	0	0	1	1	0	1	0	1	1	1	0	0	0	1	A	–
B	?	1	0	0	1	1	0	0	1	1	0	0	1	0	1	0	0	1	1	1	B	?
C	:	0	1	1	1	0	1	0	0	1	1	0	0	1	0	1	1	1	0	0	C	:
D		1	0	0	1	0	0	0	1	1	1	0	0	1	1	0	0	1	0	1	D	
E	3	1	0	0	0	0	0	1	1	1	0	0	0	0	1	1	0	1	0	1	E	3
F		1	0	1	1	0	0	0	1	0	0	1	1	1	1	0	1	1	0	0	F	
G		0	1	0	1	1	1	1	0	0	0	0	1	1	0	1	0	1	1	0	G	
H		0	0	1	0	1	1	0	1	0	0	1	0	1	0	0	1	0	1	1	H	
I	8	0	1	1	0	0	1	1	1	0	0	0	0	1	0	1	1	0	0	1	I	8
J	bell	1	1	0	1	0	0	1	0	0	0	1	1	1	1	1	0	1	0	0	J	bell
K	(	1	1	1	1	0	0	0	0	1	0	1	1	0	1	1	1	1	0	0	K	(
L	)	0	1	0	0	1	1	1	0	0	0	1	0	1	0	1	0	0	1	1	L	)
M	.	0	0	1	1	1	1	0	1	0	0	0	1	1	0	0	1	1	1	0	M	.
N	,	0	0	1	1	0	1	0	1	0	1	0	0	1	0	0	1	1	0	1	N	,
O	9	0	0	0	1	1	1	0	0	0	1	1	0	1	0	0	0	1	1	1	O	9
P	0	0	1	1	0	1	1	0	0	1	0	1	0	1	0	1	1	0	1	0	P	0
Q	1	1	1	1	0	1	0	0	0	1	1	0	1	0	1	1	1	0	1	0	Q	1
R	4	0	1	0	1	0	1	1	0	0	1	0	0	1	0	1	0	1	0	1	R	4
S	'	1	0	1	0	0	0	1	0	1	0	1	0	1	1	0	1	0	0	1	S	'
T	5	0	0	0	0	1	1	0	0	0	1	0	1	0	0	1	0	1	1	1	T	5
U	7	1	1	1	0	0	0	1	1	0	0	1	0	0	1	1	1	0	0	1	U	7
V	=	0	1	1	1	1	1	0	0	1	0	0	1	0	0	1	1	1	1	0	V	=
W	2	1	1	0	0	1	0	1	0	0	1	0	1	1	1	1	0	0	1	0	W	2
X	/	1	0	1	1	1	0	0	1	0	1	1	0	0	1	0	1	1	1	0	X	/
Y	6	1	0	1	0	1	0	0	1	0	1	0	1	1	1	0	1	0	1	0	Y	6
Z	+	1	0	0	0	1	0	1	1	0	0	0	1	1	1	0	0	0	1	1	Z	+

---

elektor infocard 85

Micro-computer-IC's 2

PROM's

PROMs (**P**rogrammable **R**ead **O**nly **M**emories) are used to store binary coded information, chiefly in micro-computers. They can be programmed in a simple manner by means of a suitable programming equipment. Simply, this means that in this procedure some diode paths on the integrated circuit are broken, others are left intact. The resulting information is permanently imprinted and cannot be altered by the computer or user. PROMs are used for a variety of purposes and are available in a multiplicity of versions. They are, for instance, found in Data Operating Systems, Character Generators and BASIC Translators in micro-computers. As PROMs cannot be erased, types with large storage capacities are generally only used in industrial applications. 'Small' PROMs can be used with advantage as replacement for 'wired' logic in certain digital circuits. PROMs are manufactured in bipolar technology.

---

elektor infocard 86

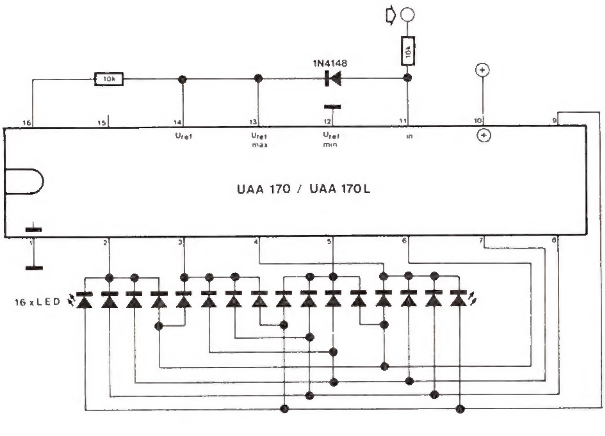
Linear ICs 8

LED Driver for Light Spot Displays

Integrated circuit UAA 170 contains all the necessary electronic control circuits for 16 LEDs. The resulting display takes the form of a moving point of light and is therefore suitable for use in tachometers, radio receiver dials, and so on.

The voltage between pins 12 and 13 determines the voltage necessary for a smooth transfer of power from one LED to the next. The resistance between pins 14 and 16 determines the brightness of the LEDs.

Supply Voltage:	11 V . . . 18 V
Technical Data at 12 V:	
Current Consumption	
without LEDs:	4 mA
with LEDs:	29 mA
Reference Voltage at pin 14:	about 5 V
Maximum Input Voltage (pins 11, 12, 13):	6 V



UAA 170 has linear characteristic
UAA 171 has logarithmic characteristic

elektor infocard 84 | Standards 12 | Telegraphy Codes

	CCITT nr. 2					CCITT Rec. 342							CCITT Rec. 476						
carriage return	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0	1	1	1	1
line feed	0	1	0	0	0	1	0	1	1	0	0	0	0	0	1	1	0	1	1
letter transfer	1	1	1	1	1	0	0	0	1	1	1	0	0	1	0	1	1	0	1
numerals/punctuation marks	1	1	0	1	1	0	1	0	0	1	1	0	0	1	1	0	1	1	0
space	0	0	1	0	0	1	1	0	1	0	0	0	0	0	1	1	1	0	1
not used	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	1	0	1	1
repeat request (RQ)						0	1	1	0	1	0	0	0	1	1	0	0	1	1
idle time alpha						0	1	0	1	0	0	1	1	1	1	1	0	0	0
idle time beta						0	1	0	1	1	0	0	1	1	0	0	1	1	0

CCITT Code no. 2 (formerly baudot code) is used in teletype communications. Where it is essential that the transmission is free of errors, a 7-bit code is used. The CCITT 342 Code is used in duplex traffic in TOR (= Telegraphy or Telex Over Radio) communications. In simplex TOR communications, CCITT Code 476 is used.

CCITT = Consultative Committe for International Telegraph and Telephone.

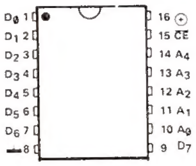
RTTY = abbreviation of Radio TeleType.

---

elektor infocard 85 | Micro-computer-IC's 2 | PROM's: Terminal Layout

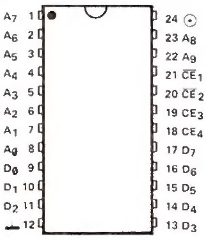
74S188 | 74S288 | 82S23 | 82S123

32 x 8 bit
+ = +5 V
D0 . . . D7 = Data Output
A0 . . . A4 = Address Input
CE = Chip Enable



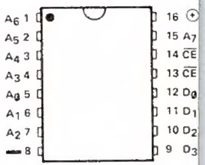
25088 | 25089 | 82S180 | 82S181

1024 x 8 bit
+ = +5 V
A0 . . . A9 = Address Input
D0 . . . D7 = Data Output
CE1 . . . CE4 = Chip Enable



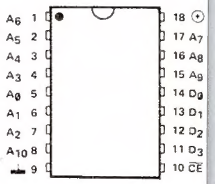
74S287* | 74S387** | 82S27* | 82S126** | 82S129*

256 x 4 bit
+ = +5 V
D0 . . . D3 = Data Output
A0 . . . A7 = Address Input
CE_1, CE_2 = Chip Enable



25084** | 25085* | 82S184** | 82S185*

2048 x 4 bit
+ = +5 V
A0 . . . A9 = Address Input
D0 . . . D3 = Data Output
CE = Chip Enable



* high impedance
** Open Collector

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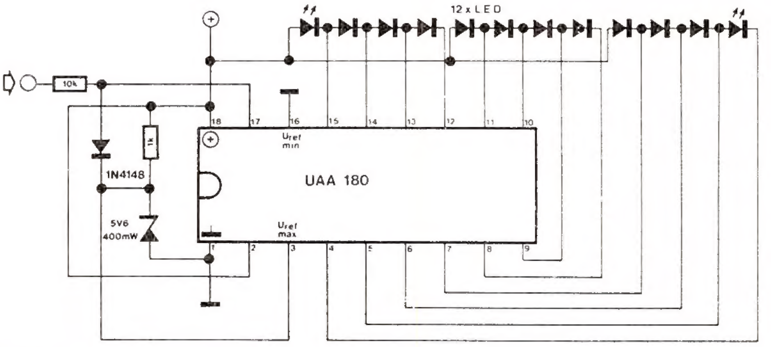
elektor infocard 86 | Linear ICs 8 | LED Driver for Light Band Displays



Integrated circuit UAA 180 contains all the necessary electronic control circuits for 12 LEDs. The resulting display takes the form of a variable strip of light which makes it suitable for use as thermometer, S-meter, (peak) programme meter, and so on.

The voltage between pins 3 and 16 determines the voltage necessary for a smooth transfer of power from one LED to the next. The level of voltage at pin 2 determines the brightness of the display.

Supply Voltage: 10 V . . . 18 V
Technical Data at 12 V:
Current consumption
without LEDs: 5.5 mA
with LEDs: 45 mA
Maximum Input Voltage
(pins 3, 16, 17): 6 V

contents

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energy meter 6-24
Our follow-up to last month's watt-meter, which enables you to keep an eye on the energy used by one or more appliances and on the effect of your energy-saving measures.

switching channel for radio control 6-28
Proportional radio control systems are readily available to modellers today. This article describes a switch which offers the possibility of controlling five non-proportional functions over one channel.

RTTY decoder 6-30
Last month we published an article on a morse decoder; now we turn to an instrument for converting teletype signals to logic 1s and 0s which can be fed to a microprocessor and displayed on a screen. An EPROM with the required program is available.

electronic aerial switch 6-36
A simple but effective method, using PIN diodes, to switch from one to another of a number of aerial inputs without introducing losses in the signal paths.

spectrum display 6-38
An interesting instrument which offers Hi-Fi enthusiasts (and other listeners) the opportunity to see what is really coming out of their amplifiers on a 10-column, 140 pixel fluorescent display. The audio range of 16 . . . 23,000 Hz is displayed in 10 octaves. The spectrum display can be used with any existing audio installation.

maestro (part 2) 6-46
The conclusion of this versatile infra-red remote control originally developed for our Prelude project but which can be used with a variety of other equipment.

video effect generator 6-50
This article describes ways and means of obtaining images on your television screen which are strongly reminiscent of trick photography.

morse and radio teletype (RTTY) 6-52
This article describes the principles of morse telegraphy and RTTY operation in some detail. Not only advanced radio amateurs and listeners but a host of others interested in the captivating hobby of listening to morse and RTTY messages on short wave radio should find many points of interest.

applicator 6-58
Fluorescent display system which can be driven directly by a computer and yet uses only one integrated circuit.

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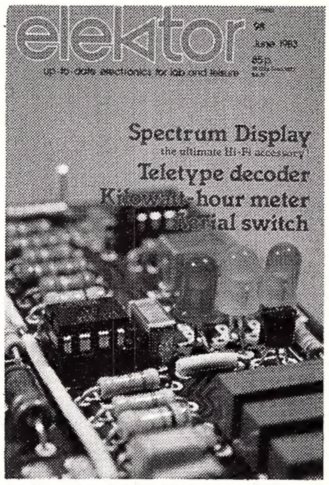

As LEDs have now been commercially available in red, green and orange/yellow for some time, they are found in many electronic applications. None the less, our front cover does not mean that we have gone into the miniature traffic light business. What is shown are the 'signal trafficators' used in the Radio Teletype decoder featured in this issue.

elektor decoder

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ABC

What is 10 n?
What is the EPS service?
What is the TQ service?
What is a missing link?

Semiconductor types
Very often, a large number of equivalent semiconductors exist with different type numbers. For this reason, 'abbreviated' type numbers are used in Elektor wherever possible:

- '741' stand for µA 741, LM 741, MC 1741, MIC 741, RM 741, SN 72741, etc.
- 'BC 107B', 'BC 237B', 'BC 547B' all refer to the same 'family' of almost identical better-quality silicon transistors. In general, any other member of the same family can be used instead.

BC 107 (-8, -9) families:
BC 107 (-8, -9), BC 147 (-8, -9), BC 207 (-8, -9), BC 237 (-8, -9), BC 317 (-8, -9), BC 347 (-8, -9), BC 547 (-8, -9), BC 171 (-2, -3), BC 182 (-3, -4), BC 382 (-3, -4), BC 437 (-8, -9), BC 414

BC 177 (-8, -9) families:
BC 177 (-8, -9), BC 157 (-8, -9), BC 204 (-5, -6), BC 307 (-8, -9), BC 320 (-1, -2), BC 350 (-1, -2), BC 557 (-8, -9), BC 251 (-2, -3), BC 212 (-3, -4), BC 512 (-3, -4), BC 261 (-2, -3), BC 416.

Resistors and capacitor values
When giving component values, decimal points and large numbers of zeros are avoided wherever possible. The decimal points is usually replaced by one of the following abbreviations:

p (pico-) = 10^{-12}
n (nano-) = 10^{-9}
µ (micro-) = 10^{-6}
m (milli-) = 10^{-3}
k (kilo-) = 10^{3}
M (mega-) = 10^{6}
G (giga-) = 10^{9}

A few examples:
Resistance value 2k7: 2700 Ω.
Resistance value 470: 470 Ω.
Capacitance value 4p7: 4,7 pF or 0.000 000 000 004 7 F . . .
Capacitance value 10 n: this is the international way of writing 10,000 pF or .01 µF, since 1 n is 10^{-9} farads or 1000 pF;
Resistors are ¼ Watt 5% carbon types, unless otherwise specified. The DC working voltage of capacitors (other than electrolytics) is normally assumed to be at least 60 V. As a rule of thumb, a safe value is usually approximately twice the DC-supply voltage.

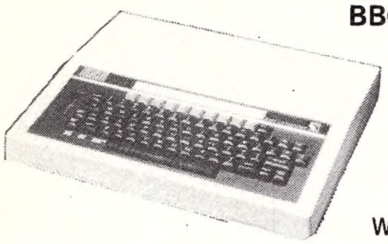
Test voltages
The DC test voltages shown are mesured with a 20 kΩ/V instrument, unless otherwise specified.

U, not V
The international letter symbol 'U' for voltage is often used instead of the ambiguous 'V'. 'V' is normally reserved for 'volts'. For instance: U_b = 10 V, not V_b = 10 V.

Mains voltages
No mains (power line) voltages are listed in Elektor circuits. It is assumed that our readers know what voltage is standard in their part of the world!
Readers in countries that use 60 Hz should note that Elektor circuits are designed for 50 Hz operation. This will not normally be a problem; however, in cases where the mains frequency is used for synchronisation some modification may be required.

Technical services to readers

- **EPS service.** Many Elektor articles include a lay-out for a printed circuit board. Some — but not all — of these boards are available ready-etched and predrilled. The 'EPS print service' in the current issue always gives a complete list of available boards.
- **Technical queries.** Members of the technical staff are available to answer technical queries (relating to articles published in Elektor) by telephone on Monday's from 13.30 to 16.15. Letters with technical queries should be addressed to: Dept. TQ. Please enclose a stamped, self addressed envelope; readers outside U.K. please enclose an IRC instead of stamps.
- **Missing link.** Any important modifications to, additions to, improvements to or corrections in Elektor circuits are generally listed under the heading 'Missing Link' at the earliest opportunity.



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47, 68, 100 **9p**; 125 **12p**; 330 **16p**; 470 **20p**; 680 **34p**; 1000 **27p**; 1500 **31p**; 2200 **36p**; 4700 **79p**.

TAG-END CAPACITORS: **64V**: 2200 **139p**; 3300 **198p**; 4700 **245p**; **50V**: 2200 **110p**; 3300 **164p**; **40V**: 4700 **180p**; **25V**: 2200 **90p**; 3300 **88p**; 4000, 4700 **98p**; 10,000 **320p**; 15,000 **345p**; **16V**: 22,000 **360p**

POLYESTER CAPACITORS: Axial Lead Type
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 **11p**; 10n, 15n, 18n, 22n **12p**; 33n, 47n, 68n **16p**; 150n **20p**; 220n **30p**; 330n **42p**; 470n **52p**; 680n 1uF **68p**; 2u2 **82p**.
160V: 10nF, 12n, 39n, 100n **11p**; 150n, 220n **17p**; 330n, 470n **30p**; 680n **38p**; 1u **42p**; 1u5 **46p**; 2u2 **48p**; 4u7 **58p**.
1000V: 1nF **17p**; 10nF **30p**; 15n **40p**; 22n **36p**; 33n **42p**; 47n, 100n **42p**.

SIEMENS pcb
Type Miniature
poly Capacitors
250V

1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 15n	**7p**
18n, 22n, 27n, 33n, 39n, 47n	**8p**
39n, 56n	**12p**
82n, 100n	**11p**

100V

100n, 120n	**10p**
150n, 180n	**12p**
220n, 270n	**15p**
330n, 390n	**20p**
470n, 560n	**28p**
680r	**30p**
1uF **34p** 2u2	**50p**

POLYESTER RADIAL LEAD CAPACITORS: 250V
10n, 15n, 22n, 27n **6p**; 33n, 47n, 68n, 100n **7p**; 150n, 220n **10p**; 330n, 470n **13p**; 680n **19p**; 1u **23p**; 1u5 **40p**; 2u2 **46p**.

FEED-THROUGH CAPACITORS
1000pF/450V **8p**

TANTALUM BEAD CAPACITORS
35V: 0.1uF, 0-22, 0-33 **15p**; 0-47, 0-68, 1-0, 1.5 **16p**; 2.2, 3-3 **18p**; 4.7, 6.8 **22p**; 10 **28p**; **16V**: 2.2, 3.3 **16p**; 4.7, 6.8, 10 **18p**; 15, **36p**; 22 **30p**; 33, 47 **40p**; 100 **75p**; **10V**: 15, 22, **28p**; 33, 47 **36p**; 100 **55p**; **6V**: 100 **42p**.

POTENTIOMETERS: Rotary, Carbon, Track 0.25W Log & Lin values.

500Ω, 1KΩ & 2KΩ (Linear only) Single Gang.	**30p**
5KΩ-2MΩ Single Gang Log & Lin	**30p**
5KΩ-2MΩ Single Gang D/P Switch	**78p**
5KΩ-2MΩ Double Gang	**89p**

MYLAR FILM CAPACITORS
100V: 1nF, 2, 4, 4nF, 10 **6p**; 15nF, 22n, 30n, 40n, 47n **7p**; 56n, 100n, 200n **9p**; **50V**: 470nF **12p**.

SLIDER POTENTIOMETERS
0-25W log and linear values 60mm

5KΩ-500KΩ single gang	**70p**
10KΩ-500KΩ dual gang	**110p**
Self Stick Graduated Bezel	**40p**

CERAMIC CAPACITORS 50V:
Range: 0-5pF to 10nF **4p**. 15nF; 22nF, 33nF; 47nF **5p**. 100nF/30V **7p**. 200nF/6V **8p**.

POLYSTYRENE CAPACITORS:
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PRESET POTENTIOMETERS
0.1W 50Ω 5MΩ Miniature

Vertical & Horizontal	**7p**
0-25W 100Ω 3-3MΩ horiz. larger	**10p**
0-25W 200Ω 4-7MΩ vert.	**10p**

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2, 3-3, 4.7, 6.8, 8.2, 10, 12, 15, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180pF	**15p each**
200, 220, 250, 270, 300, 330, 360, 390, 470, 800, 800, 820	**21p each**
1000, 1200, 1800, 2200	**30p each**
3300, 4700pF	**60p each**

MINIATURE TRIMMERS Capacitors
2-6pF, 2-10pF **22p**; 2-25pF, 5-60pF **30p**; 10-88pF **36p**.

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MICRO
4816AP
100ns
225p**

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	RANGE	Val	1-99	100 +
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1 W	2Ω2-4M7	E12	6p	4p
2% Metal Film		E24	6p	4p
1% Metal Film		E24	8p	6p

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RESISTORS Network S.I.L.
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DIODES

AA119	15
AA129	20
AAY30	15
BA100	15
BAX13	20
BY100	24
BY126	12
BY127	12
CRO33	250
OA9	40
OA47	12
OA70	12
OA79	15
OA81	20
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	15
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

NOISE Diode

Z5J	195p

VARICAPS

BA102	50
BB105B	40
BB106	40
BB109B	45
MVAM2	165

BRIDGE RECTIFIERS

1A/50V	18
1A/100V	20
1A/400V	25
1A/600V	34
2A/50V	30
2A/200V	40
2A/400V	46
2A/600V	65
6A/100V	83
6A/400V	95
6A/600V	125
10A/200V	215
10A/600V	298
25A/200V	240
25A/600V	395
BY164	56
VM18 DIL	50

ZENERS

Range: 2V7 to 39V 400mW **8p each**
Range: 3V3 to 33V. 1.3W **15p each**

TRIACS

3A 200V	54
3A 400V	56
8A 100V	60
8A 400V	69
8A 800V	115
12A 100V	78
12A 400V	82
12A 800V	135
16A 100V	103
16A 400V	105
16A 800V	220
25V 500V	220
25A 800V	295
T2800D	120

75 SERIES

75107/8	95
75110	90
75114/5	150
75121/2	130
75150	125
75154	125
75159	125
75182/3	99
75188/9	55
75322	140
75324	360
75365	150
75450	86
75451/2	52
75454	70
75491/2	65

SCR THYRISTORS

5A/40V	32
5A 400V	40
5A 600V	48
8A 300V	60
8A 600V	90
12A 100V	78
12A 400V	95
12A 800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	32
2N5064	38
2N4444	130

DIAC

ST2	25

COMPUTER ICs

1702	350
1802CP	650
2114L-300n	90
2114L-200n	95
2114-3	325
2147	425
2532	300
2564	£10
2708	225
2716-5V	225
2732-450n	350
2764	590
3242	590
4027	100
4116-150n	85
4116-200n	80
4118-250	325
4164-200n	425
4334-3 CMOS	
4532-3	350
4532-4	350
4816-100n	215
5101-450	220
6116-150n	375
6116L 120	550
6117-110n	490
6502A	450
6502CPU	325
6503	600
6504 250	550
6505	600
6520 PIA	100
6522 VIA	295
6530	£11
6352	570
6545 RTC	899
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6592 PC	£20
6800	220
6802	250
6803	850
6804	160
6805	670
6808	520
6809	630
6810	115
6820	110
6821	110
68B21	220
6840	375
6843	£12
6845	650
6847	650
6850	110
6852	250
6854	599
68B54	780
6875	500
68000	£78
74C922	400
8080 A	250
8085 A	350
8088	£18
8118-10	225
8123	125
8155	350
8156	350
81LS95	80
81LS96	80
81LS97	80
81LS98	85
8202	£25
8205	225
8212	110
8214	425
8216	100
8224	110
8225	£11
8226	250
8228	220

8243	270
8250	850
8251 A	250
8253	400
8255	225
8256 AC	£36
8257-5	400
8259	395
8271	£28
8279	385
8282	450
8283	00
8284	350
8285	365
8287	00
8288	£10
8P8304BN	250
8T26A	99
8T27	150
8T28A	120
8T31	350
8T95	90
8T97N	90
9364AP	550
9602	220
AM26LS31C	125
AM26LS32A	125
AM26LS33A	125
AY-3-1015	300
AY-5-1350	388
AY-5-2376	600
COM8017	275
COM8116	700
DM8131	275
DS3691N	320
DS88LS120N	275
DS8820	110
DS8830	110
DS8831	125
DS8832	250
E9365	£38
E9366	£38
FD1771	£15
FD1791	£22
FD1793	£23
FD1795	£28
FD1799	£28
FD1797	£28
HD26501	75
IM6402	380
INS8060N	1050
INS8154N	£9
MC1488	55
MC1489	55
MC14411	690
MC14412	725
MC3446	250
MC3447P	315
MC3486	175
MC3487	175
MC6845	625
MC6846	625
MK3886-2M	£7
MM1702A	300
MM5280D	695
MM5303	635
MM5307	1275
MM5387A	475
MM58174	700
MM74C922	420
RO-3-2513L	420
RO-3-2513U	650
SFF9634E	800
SPO256AL2	£18
TMS2716-3V	725
TMS4500	£14
TMS5100	600
TMS4532-3	350
TMS9927	£14

TMS9928	£20
TMS9929	£20
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Z80ACPU 4M	300
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Z80 PIO	260
Z80A PIO	275
Z80 SIO-1	850
Z80A SIO	£9

LINEAR ICs

555CMOS	80
702	75
709C 8 pin	35
710	48
741-8 pin	14
747C 14pin	65
748C 8 pin	36
753 8 pin	185
810	159
8037CJ	850
9400CJ	350
AD7581	£11
AY-1-1320	225
AY-1-5050	99
AY-1-5051	160
AY-1-6720	210
AY-3-1270	730
AY-3-1350	350
AY-3-8910	438
Booklet for AY-3-8910	150
AY-3-8912	450
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AY-5-1317A	630
AY-5-1350	388
CA3011	130
CA3012	175
CA3014	275
CA3018	86
CA3019	80
CA3020	210
CA3023	210
CA3028A	95
CA3035	255
CA3036	270
CA3043	275
CA3045	385
CA3046	70
CA3048	220
CA3059	285
CA3075	213
CA3080E	70
CA3081	190
CA3086	48
CA3089E	215
CA3090AQ	375
CA3123E	165
CA3130	90
CA3140	40
CA3160	95
CA3161	160
CA3162E	450
CA3189	200
HA1336W	240
HA1388	255
ICL7106	690
ICL7107	975
ICL7204	550
ICL7611	99
ICL7660	248
ICL8038CC	300

ICL8211A	150
ICM7205A	1150
ICM7207	475
ICM7215	1050
ICM7216AJ	£22
ICM7216B	£22
ULN2003	75
ICM7216C	£22
ICM7217A	750
ICM7224	785
ICM7240	300
ICM7555	80
ICM7556	150
LA3350	250
LA4031P	340
LA4032	295
LA4400	350
LA4422	320
LC7130	340
LC7120	300
LC7137	395
LF347	150
LF351	48
LF353	95
LF355	85
LF356	95
LF357	110
LF398	475
LM10	325
LM301A	24
LM307	45
LM308T	95
LM311	70
LM318N	150
LM319	215
LM324A	30
LM334Z	90
LM335Z	128
LM339	47
LM348	64
LM349	115
LM358	60
LM377	175
LM379	480
LM380	75
LM381N	145
LM382	115
LM384	160
LM386	90
LM387	120
LM389	95
LM392	60
LM393	100
LM558	75
LM725CN	325
LM733	70
LM1458	45
LM1871	325
LM2917	195
LM3302	75
LM3900	50
LM3909N	85
LM3911	125
LM3914	250
LM3915	250
LM3916	250
LM13600	110
LS7220	280
M253AA	1150
M51513L	230
M51515L	320
M51516L	475
MB3712	220
MB3756	440
MC1204	250
MC1301	79
MC1303	98
MC1304P	260
MC1310P	150
MC1445	250
MC145106	695
MC1455	50
MC1469	300

MC1494	694
MC1495	350
NC1496L	70
MC1596	225
MC1648	290
MC1709G	90
MC3302	90
MC3340P	120
MC3360P	120
MC3401	65
MC3403	75
MC3405	150
MC3423	80
MC4016	00
MF10	350
MFC6040	75
MK50398	635
ML924	275
MSM5526	820
NE515	275
NE529	225
NE531	140
NE534	150
NE543K	225
NE544	210
NE555	16
NE556	45
NE560	325
NE561	398
NE562B	410
NE564	420
NE565A	120
NE566	155
NE567V	140
NE570	410
NE571	400
NE5532	145
NE5534A	150
OM335	750
RC4136D	60
RC4558	45
S566B	225
SAB3209	425
SAB3210	325
SAB3271	485
SAB4209	595
SG3402	295
SL490	350
SL6270CD	150
SN76013	350
SN76023ND	240
SN76131	125
SN76227N	95
SN76477	420
SN76488	480
SP0256AL2	£18
SP8629	299
TA7120	125
TA7130	150
TA7204	175
TA7205	90
TA7222	150
TAA621AX1	295
TAA661A	190
TAA700	275
TAA900	395
TAB1042	110
TAD100	159
TBA120S	70
TBA540Q	275
TBA550Q	330
TBA641BX or BX11	290
TBA651	190
TBA800	80
TBA810	95
TBA820	80
TBA920Q	200
TBA950	300
TBA990Q	350
TBA540	275

TC9109	775
TCA220	350
TCA270Q	350
TCA280A	220
TCA940	175
TCA965	145
TDA1004	290
TDA1008	310
TDA1022	499
TDA1024	115
TDA1034	350
TDA1490	350
TDA2002	325
TDA2003	198
TDA2004	495
TDA2006	330
TDA2020	320
TDA2030	295
TDB0701	420
TL170	50
TL430	65
TL507	110
TL061CP	40
TL062CP	60
TL064CN	98
TLO71CP	74
TLO72CP	45
TLO74CN	100
TLO81CP	24
TLO82CP	45
TLO83CP	75
TLO84CN	90
TLO91CP	55
UA2240	120
UA78540	230
UAA170	170
UAA180	180
UGN3020T	160
ULN2001	80
ULN2003	75
ULN2004	75
ULN2283	100
UPC575	275
UPC1025H	375
UPC1156H	275
UPC1366	195
XR2206	300
XR2207	375
XR2211	575
XR2216	675
XR2266	360
ZN414	80
ZN419E	180
ZN423E	130
ZN424E	130
ZN425E	345
ZN426E	300
ZN427E	600
ZN428E	410
ZN429E	210
ZN459	570
ZN1034E	200
ZN1040E	665
ZNA234E	850

TRANSISTORS

AC126/7	36
AC141/2	30
AC176	28
AC187	32
AC188	32
ACY19/21	75
ACY22/41	75
AD142	120
AD149	79
AD161	42
AD162	42
AF115/6	60
AF118	80
AF124/26	70
AF139	40
AF178	75
AF186	70
AF239	55
BC107	10
BC107B	12
BC108	10
BC108B	12
BC109	10
BC109B	12
BC109C	12
BC114/5	22
BC117/8	20
BC137/9	40
BC142/3	30
BC147	9
BC147B	10
BC148	9
BC148B	10
BC149	9
BC149C	10
BC153/4	27
BC157/8	10
BC159	11
BC160	46
BC167A	10
BC168C	10
BC169C	10
BC170	15
BC171/2	11
BC173	11
BC177/8	16
BC179	20
BC181	20
BC182/3	10
BC184	10
BC182L	10
BC183L	10
BC184L	10
BC186/7	28
BC212	10
BC212L	10
BC213	10

BC213L	10
BC214	10
BC214L	10
BC237/8	14
BC307B	14
BC308	16
BC256B	30
BC318	30
BC327/8	15
BC337/8	15
BC441/61	34
BC477	40
BC516/7	40
BC547/8	12
BC549C	14
BC556/7	15
BC558/9	15
BCY45	50
BCY58/59	36
BCY70/71	16
BCY72	20
BCY78	24
BD121	96
BD124	115
BD131/32	48
BD133	70
BD135	46
BD136/37	40
BD138/39	40
BD140	40
BD144	190
BD158	55
BD205/6	110
BD245	45
BD378	70
BD517	75
BD645	80
BD695A	125
BD696A	125
BF115	36
BF154/8	25
BF184/5	38
BF194/5	12
BF198/9	18
BF200	80
BF224A	25
BF224B	29
BF245	30
BF256A	36
BF256B	46
BF257/8	32
BF259	35
BF336/7	40
BF494/5	30
BF594/5	30

BFR39/40	23
BFR41/79	23
BFR80/81	25
BFR98	106
BFX29	28
BFX81	45
BFX84	28
BFX85/6	28
BFY50/51	23
BFY52	23
BFY53	32
BFY55/6	32
BFY64	35
BFY81	120
BFY90	80
BRY39	40
BSX20	20
BSX26/29	34
BU105	170
BU205	190
BU206	200
BU208	200
BUY69C	225
E421	250
MD8001	250
MJ2955	70
MJE170	150
MJE180	150
MJE340	54
MJE370	100
MJE371	100
MJE520	96
MJE521	96
MJE2955	99
MJE3055	70
MPF102	40
MPF103	30
MPF104	30
MPF105	30
MPF106	40
MPSA05	25
MPSA08	25
MPSA12	32
MPSA55	30
MPSA56	30
MPSA70	30
MPSU02	58
MPSU05	56
MPSU06	56
MPSU52	65
MPSU55	50
MPSU56	60
MPSU56	60

OC26	170
OC28/35	220
OC36/41	75
OC42	50
OC70	40
OC71/72	40
OC75/76	40
OC81/82	50
OC83/84	40
OC170/71	50
TIP29A	32
TIP29C	38
TIP30A	35
TIP30C	37
TIP31A	38
TIP31B	39
TIP31C	39
TIP32A	36
TIP32C	42
TIP33A	65
TIP33C	78
TIP34A	74
TIP34C	88
TIP35A	110
TIP35C	128
TIP36A	130
TIP36C	140
TIP41A	50
TIP41B	52
TIP42A	55
TIP42B	58
TIP120	70
TIP121/2	73
TIP141/2	106
TIP147	120
TIP2955	60
TIP3055	60
TIS43	32
TIS44/5	45
TIS /74	50
TIS88A	50
TIS90/91	30
UC734	65
VK101	80
VN10KM	55
VN46AF	78
VN66AF	80
VN88AF	94
VN89AF	96

ZTX300	13
ZTX301	16
ZTX302	16
ZTX303	25
ZTX304	17
ZTX314	25
ZTX326	30
ZTX341	30
ZTX451	23
ZTX500	14
ZTX501/2	15
ZTX503	18
ZTX504	25
ZTX531	25
ZTX550	25
2N697	23
2N698	40
2N699	48
2N706A	19
2N708	19
2N918	35
2N1131/2	24
2N1671B	160
2N160	295
2N2219A	28
2N2220A	26
2N2221A	26
2N2222A	26
2N2368	25
2N2369A	18
2N2483/4	27
2N2646	46
2N2904/5	26
2N2906/7	26
2N2907A	26
2N2926G	10
2N3053	26
2N3054	58
2N3055	48
2N3252	46
2N3441/2	140
2N3614/5	199
2N3663	15
2N3702/3	10
2N3704/5	10
2N3706/7	10
2N3708/9	10
2N3710/11	10
2N3713	140
2N3771	179
2N3772	196
2N3773	210
2N3819	22

2N3820	36
2N3822/3	45
2N3824	66
2N3866	90
2N3903/4	15
2N3905/6	15
2N3906	17
2N4037	46
2N4058	10
2N4061/2	10
2N4064	115
2N4234	48
2N4264	24
2N4286	15
2N4289	18
2N4314	78
2N4400	18
2N4427	80
2N4871	55
2N4898	135
2N5135/6	20
2N5138	18
2N5172	18
2N5179	45
2N5180	45
2N5190/1	75
2N5194	80
2N5305/8	30
2N5457/8	30
2N5459	30
2N5485	36
2N5777	46
2N5879	190
2N6027	32
2SA671	250
2SA715	60
2SC495	70
2SC496	70
2SC1061	250
2SC1096	85
2SC1162	30
2SC1173	125
2SC1306	100
2SC1307	150
2SC1449	85
2SC1678	140
2SC1679	190
2SC1923	50
2SC1945	225
2SC1963	90
2SC1957	90
2SC1969	140
2SC2028	85

2SC2029	210
2SC2078	170
2SC2091	85
2SC2314	85
2SC2166	195
2SC2335	225
2SC2547	30
2SC2612	225
2SD234	74
2SK45	90
2SK288	225
2SJ83	225
2SJ85	225
3N128	112
3N140	112
40315	90
40316	95
40324	100
40326/7	70
40347	90
40348	120
40360	80
40361/2	70
40407/8	75
40411	285
40412	90
40467A	130
40468	85
40594	105
40603	110
40673	75
40871/2	90

RF CHOKES Miniature PCB type

1uH, 2u2, 4u7, 10u, 22u, 33u, 47u, 100u, 220u, 330u, 470u	**30p**
1mH, 1m5, 2m2, 4m7, 10mH	**35p**
22m, 33m, 43m	**60p**
100m	**75p**

TTL74

7400	11
7401	11
7402	11
7403	12
7404	13
7405	15
7406	20
7407	20
7408	14
7409	14
7410	14
7411	16
7412	18
7413	18
7414	24
7416	20
7417	20

7420	15
7421	20
7422	20
7423	20
7425	18
7426	18
7427	15
7428	26
7430	14
7432	22
7433	22
7437	25
7438	22
7440	15
7441	55
7442	32
7443	90
7444	90
7445	55
7446	60
7447	40
7448	45
7450	16
7451	16
7453	16
7454	16
7460	16
7470	35
7472	24
7473	26
7474	20
7475	25
7476	25
7480	48
7481	120
7482	65
7483	38
7484	70
7485	60
7486	20
7489	170
7490	20
7491	35
7492	25
7493	25
7494	35
7495	35
7496	35
7497	90
74100	80
74104	50
74105	55
74107	20
74109	25
74110	35
74111	55
74112	170
74116	50
74118	55
74119	60
74120	60
74121	25
74122	35
74123	35
74125	35
74126	35
74128	35
74132	30
74136	28
74141	55
74142	175
74143	210
74144	210
74145	50
74147	75
74148	60
74150	50
74151	40
74153	40
74154	55
74155	40
74156	40
74157	30
74159	80

74160	80
74161	48
74162	40
74163	40
74164	40
74165	48
74166	48
74167	150
74170	125
74172	250
74173	60
74174	54
74175	55
74176	40
74177	45
74178	80
74179	80
74180	40
74181	115
74182	60
74184	90
74185	95
74188	250
74190	48
74191	46
74192	46
74193	45
74194	40
74195	40
74196	46
74197	40
74198	80
74199	84
74221	54
74246	120
74247	120
74248	120
74249	120
74251	65
74259	150
74265	55
74273	150
74276	120
74278	100
74279	50
74283	50
74284	155
74285	155
74290	105
74293	80
74297	236
74298	100
74351	195
74365	30
74366	30
74367	30
74368	30
74390	75
74393	90
74490	95

74C

74C244	195
74C245	195
74C373	240
74C374	245
74C922	420
74C923	500

74S

74S00	30
S02	30
S03	30
S04	30
S05	60
S08	60
S20	40
S32	70
S74	75
S86	65
S112	80
S114	80
S132	110
S133	60
S138	100
S139	115
S157	225
S158	210
S188	140
S189	140
S194	195
S195	195
S201	250
S225	240
S241	250
S244	290
S251	170
S257	170
S262	850
S287	225
S288	210
S289	200
S301	350
S412	380
S470	325
S471	620
S472	1150
S475	800
S571	620

74LS

LS00	11
LS01	11
LS02	11
LS03	12
LS04	12
LS05	12
LS08	12
LS09	12
LS10	12
LS11	12
LS12	13
LS13	15
LS14	26
LS15	12
LS20	12
LS21	12
LS22	12
LS24	75
LS26	12
LS27	13
LS28	14
LS30	13
LS32	13
LS33	15
LS37	15
LS38	15
LS40	13
LS42	28
LS47	35
LS48	45
LS49	50
LS51	14
LS54	14
LS55	14
LS63	120
LS73	18
LS74	18
LS75	20
LS76	18
LS78	18
LS83	36
LS85	42
LS86	16
LS90	24
LS91	60
LS92	32
LS93	23
LS95	40
LS96	95
LS107	40
LS109	23
LS112	22
LS113	20
LS114	22
LS122	36
LS123	36
LS124	90
LS125	24
LS126	25
LS132	30
LS133	30
LS136	24
LS138	25
LS139	28
LS145	70
LS147	100
LS148	75
LS151	40
LS153	40
LS155	30
LS156	36
LS157	25
LS158	30
LS160	32
LS161	37
LS162	35
LS163	35
LS164	43
LS165	50
LS166	52
LS168	84
LS170	70
LS173	50
LS174	36
LS175	36
LS181	90
LS183	105
LS190	36
LS191	36
LS192	36
LS193	37
LS194	35
LS195	35
LS196	45
LS197	45
LS200	275
LS202	275
LS221	55
LS240	55
LS241	55
LS242	55
LS243	55
LS244	50
LS245	70
LS247	50
LS248	55
LS249	55
LS251	30
LS253	32
LS257	30
LS258	36
LS259	55
LS260	22
LS261	100
LS266	20
LS273	54
LS275	125
LS279	30
LS280	90
LS283	40
LS290	40
LS293	40
LS295	75
LS298	80
LS299	150
LS300	175
LS302	175
LS320	200
LS323	160
LS324	168
LS325	295
LS326	240
LS327	240
LS347	95
LS348	90
LS352	62
LS353	62

SWITCHES

TOGGLE: 2A, 250V.

SPST	33p
DPDT	44p

SUB-MIN TOGGLE

SPST on/off	54p
SPDT c/over	60p
SPDT centre off	85p
SPDT biased both ways	105p
DPDT 6 tags	75p
DPDT centre off	88p
DPDT biased both ways	145p
DPDT 3 positions on/on/on	185p
3-pole 2 way	205p

SLIDE 250V:

DPDT 1A	14p
DPDT 1A c/off	15p
DPDT ½A	13p

PUSHBUTTON 6A
with 10mm Button

SPDT latching	99p
DPDT latching	145p
SPDT moment	99p
DPDT moment	145p

Mini Non Locking

Push to Make	15p
Push to Break	25p

DIL SWITCHES
(SPST) 4 way **70p**; 6 way **85p**; 8 way **90p**; 10 way **145p**. (SPDT) 4 way **190p**.

ROTARY SWITCHES:
(Adjustable Stop type)
1 pole/2 to 12 way; 2p/2 to 6 way; 3 pole/2 to 4 way; 4p/2 to 3 way **45p**

ROTARY: Mains DP 250V 4 Amp on/off **68p**

ROTARY: (Mak-a-switch)
Make a multiway switch. Shafting assembly has adjustable stop. Accommodates up to 6 wafers (max. 6 pole/12 way + DP switch). Mechanism only **90p**

WAFERS: (make before break) to fit the above switch mechanism.
1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6-/2 way **65p**
Mains DP 4A Switch to fit **45p**
Spacers **4p**. Screen **6p**

ROCKER: 5A/250V SPST	28p
ROCKER: 10A/250V SPDT	38p
ROCKER: 10A/250V DPDT c/off	95p
ROCKER: 10A/250V DPST with neon	85p

THUMBWHEEL Mini front mounting

Decade Switch Module	220p
B.C.D. Switch Module	275p
Mounting Cheeks (per pair)	75p

VEROBOARD 0.1in

	clad	plain
2½ × 3¼	85p	—
2½ × 5"	100p	—
3¾ × 3¾	100p	—
3¾ × 5"	115p	—
3¾ × 17"	390p	198p
4¾ × 17"	495p	275p
Pkt. of 100 pins		55p
Spot face cutter		150p
Pin insertion tool		185p

VQ Board	195p
DIP Board	395p
Vero Strip	95p

PROTO DECs

Veroblock	405p
S-Dec	360p
Eurobreadboard	520p
Bimboard 1	575p
Superstrip SS2	1350p

VERO WIRING PEN + spoool **340p**
Spare spool **75p**
Combs **6p**

DALO ETCH RESIST PEN
Plus spare tip **90p**

FERRIC CHLORIDE
1 lb bag Anhydrous
195p + 50p P&P

ULTRASONIC TRANSDUCER
40KHz **325 pr**

COPPER CLAD BOARDS

Fibre glass	Single-sided	Double-sided	S.R.B.P. 9.5" × 8.5"
6" × 6"	90p	110p	95p
6" × 12"	150p	195p	

IDC CONNECTORS

	PCB Plugs with latch Pins Strt	PCB Plugs with latch pins Angle	Female Header Plug	Female Card Edge Connect
10 way	90p	99p	85p	120p
16 way	130p	150p	110p	—
20 way	145p	168p	125p	195p
26 way	175p	200p	150p	240p
34 way	205p	236p	169p	320p
40 way	220p	250p	190p	340p
50 way	235p	270p	200p	395p
60 way	—	—	230p	495p

EURO CONNECTORS

	Female Socket Strt. Pins	Female Socket Angle Pins	Male Plug Strt. Pins	Male Plug Angle Pins
DIN41617 31way	170p	—	—	175p
DIN41612 2x32 A+B	275p	320p	220p	285p
DIN41612 2x32 A+C	295p	340p	240p	300p
DIN41612 3x32 A+B+C	360p	385p	260p	395p

PANEL METERS

FSD
60 × 46 × 35mm
0-50μA
0-100μA
0-500μA
0-1mA
0-5mA
0-10mA
0-50mA
0-100mA
0-500mA
0-1A
0-2A
0-25V
0-50V AC
0-300V AC
"S"
"VU"
425p each

RELAYS

Miniature, enclosed, PCB mount.

SINGLE POLE Changeover
RL6-91 205 Ω Coil; 12 V DC (10V5 to 19.5 V). 10 A at 30 V DC or 250 V AC **185p**

DOUBLE POLE Changeover. 6 A 30 V DC or 250 V AC
RL6-100 53 Ω Coil, 6 V DC (5V4 to 9V9) **190p**
RL6-111 205 Ω Coil, 12 V DC (10V7 to 19V5) **195p**
RL6-114 740 Ω Coil, 24 V DC (22 V to 37 V) **200 p**

AMPHENOL PLUGS

IEEE 24 Way	550
Centronics Parallel 36 Way solder	530
Centronic Parallel 36 way IDC	495

BUZZERS, miniature. solid-state 6V: 9V & 12V **70p**

PIEZO TRANSDUCERS
PB2720 **55p**

LOUDSPEAKERS
Miniature, 0.3W: 8Ω

2in, 3½in, 2½in, 3in	80p
2½in 40Ω, 64Ω or 80Ω	90p

ASTEC UHF MODULATORS

Standard 6 MHz	350p
Wideband 8 MHz	480p

ELEKTOR PROJECTS
We stock most of the parts

JUMPER LEADS (Ribbon Cable Assembly)

Length	14 pin	16 pin	24 pin	40 pin
Single ended DIP (Header Plug) Jumper				
24 inches	145p	165p	240p	380p
Double ended DIP (Header Plug) Jumper				
6 inches	185p	205p	300p	465p
12 inches	198p	215p	315p	490p
24 inches	210p	235p	345p	540p
36 inches	230p	250p	375p	595p

IDC Female Header Socket Jumper Leads 24"

	20 pin	26 pin	34 pin	40 pin
Single ended	180p	200p	280p	300 p
Double ended	290p	370p	480p	525p

DIL SOCKETS

	Low Prof	Wire Wrap
8pin	8p	25p
14pin	10p	35p
16pin	10p	42p
18pin	16p	52p
20pin	20p	60p
22pin	22p	65p
24pin	25p	70p
28pin	28p	80p
40pin	30p	99p

EDGE CONNECTORS

	.1	.156
2 × 15 way	—	140p
2 × 18 way	180p	145p
2 × 22 way	199p	200p
2 × 23 way	175p	—
2 × 25 way	225p	220p
2 × 28 way	190p	—
2 × 30 way	245p	—
2 × 36 way	295p	—
2 × 40 way	315p	—
2 × 43 way	395p	—
2 × 75 way	550p	—

DIL PLUG (Header)

	Solder	IDC
14pin	40p	99p
16pin	49p	105p
24pin	88p	178p
40pin	250p	255p

ZIF DIL SOCKETS

24 pin	575p
28 pin	820p
40 pin	975p

RIBBON CABLE
price per foot

	Grey	Color
10 way	15p	28p
16 way	25p	40p
20 way	30p	50p
24 way	40p	65p
34 way	60p	85p
40 way	70p	90p
50 way	85p	110p
64 way	100p	135p

CRYSTALS

32.768KHz	100
100KHz	236
200KHz	268
455KH	370
1MHz	275
1.008M	275
1.28MHz	392
1.6MHz	395
1.8NHz	395
1.8432M	200
2.0MHz	225
2.4576M	200
3.278M	150
3.5794M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.80MHz	200
4.194304M	200
4.433619M	100
5.0MHz	160
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	150
6.5536MHz	225
7.0MHz	150
7.168MHz	250
7.68MHz	200
8.0MHz	150
8.08333M	395
8.86723M	175
9.00MHz	150
10.0MHz	175
10.24MHz	200
10.7	150
12.0MHz	175
12.528M	300
14.31814M	170
16.0MHz	200
18.0MHz	180
18.432M	150
20.0MHz	200
19.968MHz	150
24.0MHz	170
24.930MHz	325
26.69M	150
27.648M	170
27.145M	190
38.66667M	175
48.0MHz	170
100.0MHz	295
116.0MHz	250

MONITORS

- ZENITH – 12" Green, Hi-Resolution Popular £ 75
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6V	78LO6	30p	—	
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10	24	4086	80	4555	36
11	10	4089	125	4556	36
12	16	4093	20	4557	320
13	20	4094	70	4558	120
14	46	4095	95	4559	396
15	40	4096	70	4560	160
16	20	4097	290	4561	104
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1	40	4502	80	40108	198
2	40	4503	40	40109	80
3	40	4504	75	40110	198
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0	25	4512	50	40182	90
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2	60	4514	115	40193	70
3	50	4515	115	40194	70
4	85	4516	55	40195	75
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	436	4520	60	40373	160
	45	4521	90	40374	160
	1195	4522	125	45106	596
	995	4526	70		
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	245	4529	150		
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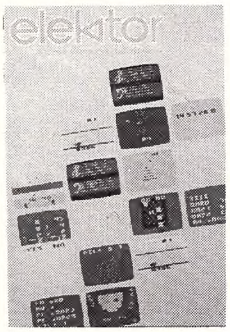
E34, February 1978
Infra-red Light Gate/Throwing Some Light on LEDs/Formant – the Elektor Music Synthesiser (8)/Slow on/off/CMOS Function Generator/Zener Tester/Development Timer/Experimenting with the SC/MP (4).

E37, May 1978
Aerial Systems for Satellite Communication/Digital Reverberation Unit/Mini Short-wave Receiver/Vocoder (2)/Percolator Switch/Colour Modulator/ Circuit Boards and Soldering/Universal Logic Tester.

E38, June 1978
1/4 GHz Counter/Constant Amplitude Squarewave to Sawtooth Converter/Servo Polarity Changer/ Monopoly Dice/ Mini Counter/Digital Clock Using the SC/MP/Programmable Call Generator/TV Sound Modulator/ Automatic Stereo Switch/Traffic Light Controller/Easy Music.

E48, April 1979
µP TV Games/Car Light Reminder/Stentor/TAP Switch/Assistentor/Zero pF Screen/Quiz Master/Building the TV Games Computer.



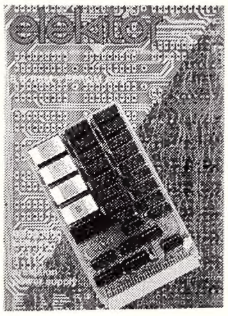
E54, October 1979
Touch Tuning/Battery Saver/Impedance Bridge/New Programs for the SC/MP/Digital Rev Counter/Digifarad/Short-interval Light Switch/PCB for Variable Fuzz Box/Gate-dipper/Strain Gauge/I Played TV Games/Programmable Sequencer.

E55, November 1979
Topamp/Flash Sequencer/Electronics the Easiest Way/Remote Control Motor Switch/ Home Trainer/Fuel Economiser/ I Played TV Games (2)/Shortwave converter/Ionosphere/Low Voltage Dimmer/I See your Point/Servo-controlled Motor.

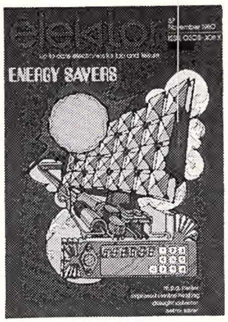
E58, February 1980
Aerial Booster/Fet Opamps in the Formant/TV Interference Suppression / Elektor Vocoder (2)/Aerial Amplifiers/Digisplay/ Analogue Delay Technology/Extending the 1/4 GHz Counter/ Digital Thermometer.

E63/64, July/August 1980
Summer Circuits Double Issue containing over 100 projects.

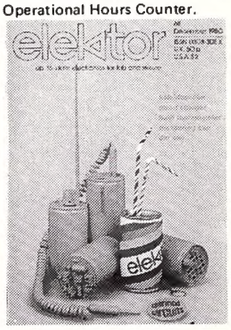
E65, September 1980
8K RAM +4.8 or 16K EPROM on a Single Card/Precision Power Unit/Electronic Linear Thermometer/The Josephson Computer/VOX Printed Circuit Board/Ejektor: Measuring Multipath/High Speed Readout for Elekterminal/Musical Box/Electrolytology/Curve Tracer/Using the Vocoder.



E66, October 1980
Programmable Slide Fader/Touch Doorbell/Switched Capacitors/ More TV Games/The Junior Computer Memory Card/Remote Control Slide Projector/Video Pattern Generator/LCD Tuning Scale/Dual Slide Faders.

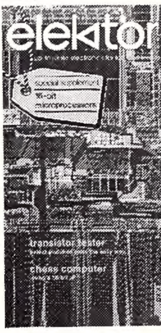


E67, November 1980
An r.p.m. Indicator as an Economy Guide/Draught Detector/How to Recycle Dry Cell Batteries/Energy Saving Knowhow/Simple Fuel Economy Meter/Automatic Pump Control /Long Life Technique in Light Bulbs/Automatic Curtain Control/Fridge Alarm/Know the ins and outs of your Central Heating System/Energy Saving Motor Control/Coffee Machine Switch/ Operational Hours Counter.



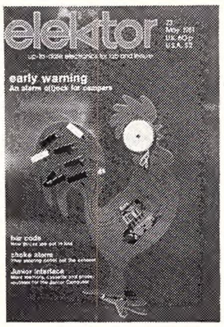
E68, December 1980
Canned Circuits: 23 of the best entries which include Midnight Raid Detector/A 'Flash in the Can' / Canometer / Canine Defence.

E70, February 1981
Audio Power Meter/Noise Reduction / Process Timer / High voltage from 723 / Juniors Growing Up/The Voiced/Unvoiced Detector / Emergency Brake for the Power Supply/ 150 W DC to DC Converter for the Car/Low Noise 2 Metre Pre-Amp/2½ Digit DVM/Wagnephon.



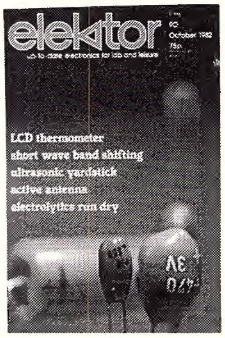
E72, April 1981
Transistor Match-maker/Universal Power Supply/Intelekt/Humidity Sensor/Logic Analyser II/ Crystal-controlled Stroboscope/ Junior Cookbook.

E73, May 1981
Camping Clock / Frequency Doubler/The Fully Fledged Junior Computer/Talk to Computers/Choke Alarm/Bar Codes/ Logic Analyser/Waveform Generator/Sophisticated Software for the Junior Computer/Reading Bar Codes.



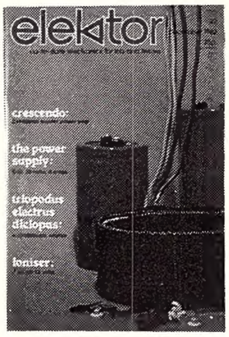
E77, September 1981
DFM + DVM/Revolution Counter/Digital Barometer/dB Converter/TV Games Extended/ Disco Lights Controller/QUAD ESL 63/Analogue LED Display/ Volt/Ammeter for Power Supplies/Chattering Chips/Transistor Ignition Update/Soldering Aluminium.

E89, September 1982
Gas Detector/Rapid Loading Games/The Elektor Connection/ Inductive Sensor / Darkroom Computer Part 1 / Applikator/ Home Telephone System/Synthesised Sound Animation/Time Receiver for the Rugby MSF/ Three Phase Tester.



E90, October 1982
DSB Demodulator/L.C.D. Thermometer/Ultra Sonic Distance Measurement/Electrolytics Run Dry/Darkroom Computer Part 2/Short Wave Band Shifting for SSB Receiver/16 Channels with only Five ICs/Pre-amp for the SSB Receiver / Active Aerial / Transistor and IC Data.

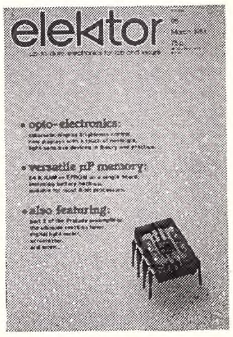
E91, November 1982
Drum Interface/Talking Dice/ Model Train Lighting/Guitar Tuner/Cerberus/Floppy Disc Interface for the Junior/Cubular Bell/Mini-Organ Extension/ Kitchen Timer.



E92, December 1982
Triopede/Precision Power Supply/The XL System/Crescendo/ Home Telephone Help/Soft Switching/In-car Ioniser/Floppy Disc Interface for the Junior Part II/A Dozen and One Sounds /Stop-signal Override for Model Railways.

E93, January 1983
Milliohmmeter/accessories for the Crescendo power amplifier/ Darkroom computer tips/Chips for digital audio/3 A computer supply/Traffic-light control system / Tomorrow's music / Upper and lower case on the Elekterminal.

E94, February 1983
Prelude part 1/VAM – video/ audio modulator / Main beam dimmer/Prelude class A headphone amplifier/Fuse protector/ Acoustic telephone modem/ Double dice/Chips for digital audio part 2.



E95, March 1983
Fluorescent displays/Servo-tester /LCD luxmeter/Universal memory card/Prelude part 2/Automatic display dimmer/Reaction tester/O, IC/Audio traffic light.

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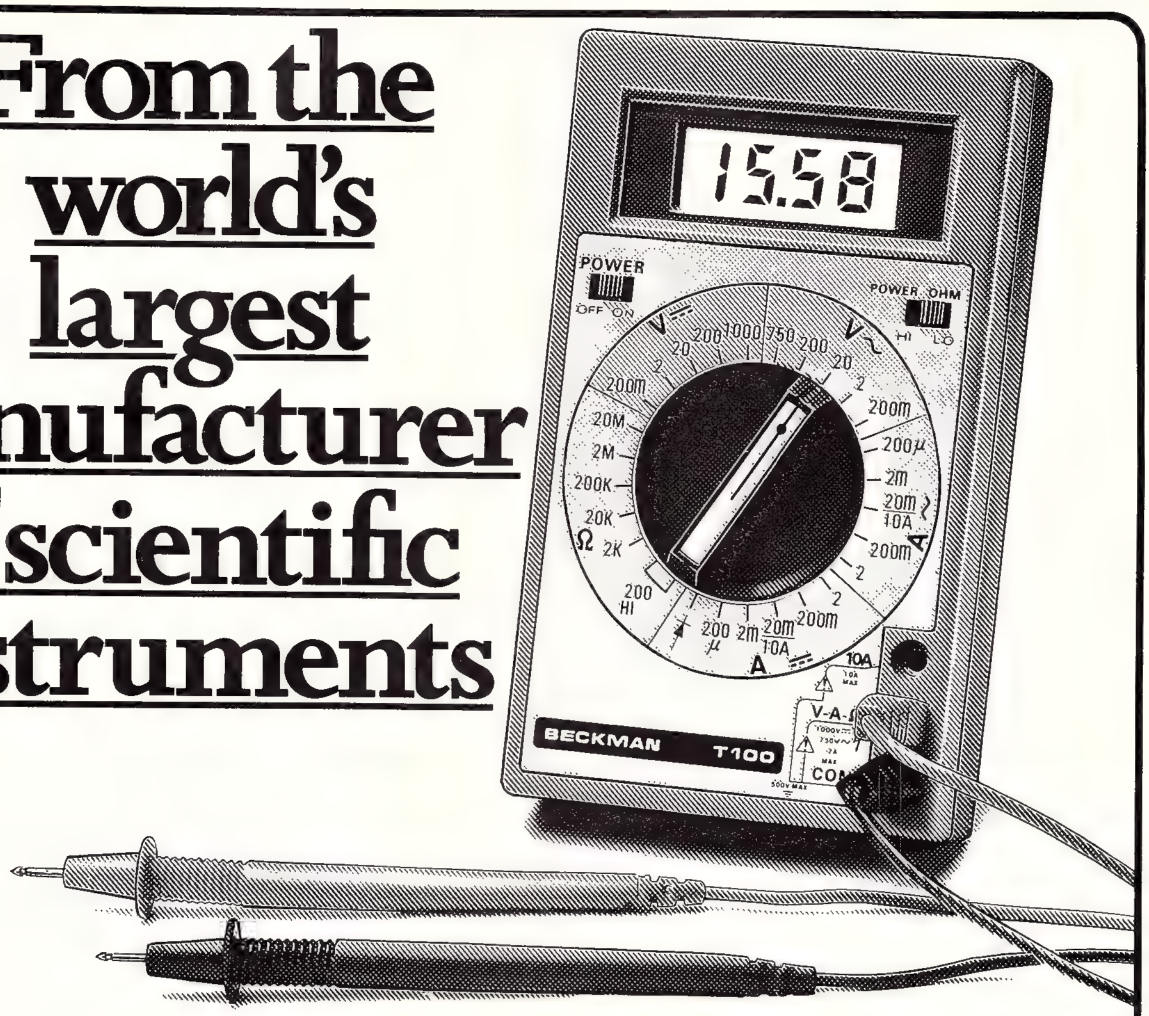

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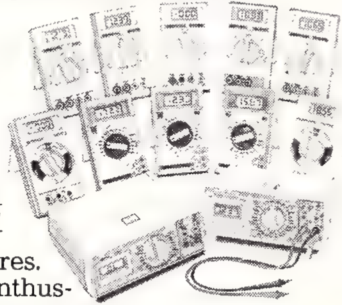

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40 CRICKLEWOOD BROADWAY, LONDON NW2 3ET. Tel: 01-4520161 TELEX: 914977 CRIKEL G

SUPERIOR QUALITY CARBON FILM RESISTORS' HISTAB LOW NOISE

¼ W 10 Ω	1MΩ 5% E24	2p
½ W 10Ω	10MΩ 5% E24	3p
1 W 10Ω	10MΩ 5% E12	6p
2 W 10Ω	10MΩ 5% E12	15p

METAL OXIDE/FILM RESISTORS

Very high thermal & electrical stability. Extremely low noise

0.4 W 10Ω	1MΩ 2% E24	5p
0.1 W 10Ω	1MΩ 1% E24	8p

LOW OHMIC VALUE RESISTORS
(½ W OR ¼ W)

0.22Ω 8.2Ω E12	11p

WIREWOUND RESISTORS 5%

2.3 W 0.22Ω 330Ω E12	28p
4.7 W 0.47Ω 6K8 E12	33p
10 11 W 1.0Ω 33K E12	37p

LOW NOISE ROTARY POTS
E3 Series

4.7K 2M Lin	32p
4.7K - 2M Log	32p
As above with DP switch	80p
As above but stereo (no switch)	90p

MICRO MINI 100V CERAMIC PLATE CAPS
5% or better
E12 Series
1pF - 10nF 7p
DISCOUNTS ON QUANTITY PLEASE PHONE

SIEMENS 63V MINI MONOLYTHIC CERAMIC

10nF	10p
22nF	10p
33nF	10p
47nF	10p
68nF	10p
100nF	14p

SIEMENS POLY-C 5% 7.5mm 250V CAPACITORS
E12

1nF 68nF	10p
82nF 150nF	15p

5% 7.5mm 100V CAPACITORS
E12

100nF 180nF	12p
220nF 270nF	15p
330nF 390nF	20p
470nF 560nF	27p
680nF	32p
1µF (10mm)	35p

Complete range of other voltages & spacings in stock
Please phone

ICE MULTI-METERS
Microtest 80 £ 16.00
Supertest 680R £ 32.00

TANTALUM BEADS

1/35 V	14p
22/35 V	14p
33/35 V	14p
47/35 V	14p
68/35 V	14p
1.0/35 V	14p
2.2/16 V	14p
2.2/35 V	22p
3.3/35 V	22p
4.7/16 V	22p
4.7/35 V	24p
6.8/25 V	26p
6.8/35 V	25p
10/16 V	25p
10/35 V	34p
15/10 V	22p
15/25 V	32p
22/6.3 V	26p
22/15 V	32p
33/10 V	38p
47/6.3 V	43p
100/3 V	37p

Feedthrough Capacitor
1000pF 500V 7p

MINI FILM MULLARD TRIMMERS

1.4 5pF (800MHz)	23p
2 10 pF (600MHz)	27p
2 22pF (400MHz)	29p
5.5 65pF (200MHz)	36p

630VDC 250VAC POLYESTER CAPS

10nF	12p
15nF	18p
22nF	18p
47nF	32p
100nF	35p
150nF	37p
220nF	40p

Fully enclosed Piher Pre sets
E 3 Series
100Ω 10M

Cermet 20 Turn Precision Preset
50Ω, 100Ω, 200Ω, 500Ω, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 250K, 500K
99p each

Mini Vert	14p
Mini Horiz	14p
Standard Vert	17p
Standard Horiz	17p
Thumbwheel or ¼" Spindle for Standard Pre sets only	8p

160V Polystyrene Caps 5% or better
10pF 15pF, 22pF 27pF, 33pF 39pF, 47pF 68pF, 100pF 150pF, 180pF 220pF, 270pF 330pF, 390pF 470pF, 680pF 820pF, 1nF 1.5nF, 2.2nF, 3.3nF, 4.7nF, 10nF
12p each

C280 or Equiv Polyester Caps Radial Long Leads

10nF 15nF, 22nF 33nF, 47nF 68nF, 100nF	9p
150nF, 220nF,	11p
330nF, 470nF	18p
680nF, 1µF	24p
1.5µF, 2.2µF	44p

Veroboard 0.1" Copper Clad

2.5 x 3.75	79p
2.5 x 5	89p
3.75 x 3.75	89p
3.75 x 5	1.05
2.5 x 17	2.75
3.75 x 17	3.60
4.79 x 17	4.66
VQ Board	1.80
Dip Board	3.50
Track Cutter	1.35
Pin Inserter	1.79
100 Pins	49p
Verobloc	3.95
Vero Wiring	
Pen + Spool	3.35
Spare Spool	75p
Combs	6p

Ferric Chloride
Pellets — enough to make 1 litre £ 1.60

Quality Electrolytics

By Matsushita or Siemens
(other good makes may be sent only in the rare event of supply difficulty)

AXIALS

uFd	V	
47	63	8p
47	100	9p
.47	350	30p
1	63	8p
1	100	9p
1	500	40p
2.2	25	8p
2.2	63	9p
2.2	100	11p
2.2	350	30p
3.3	25	10p
3.3	40	11p
3.3	63	12p
4.7	16	8p
4.7	25	9p
4.7	40	11p
4.7	63	12p
4.7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
10	350	55p
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	26p
47	100	28p
100	16	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	25p
220	63	30p
220	100	40p
330	16	19p
330	25	22p
330	63	38p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	38p
1000	40	46p
1000	63	65p
2200	16	40p
2200	25	63p
2200	40	70p
2200	63	134p
4700	16	75p
4700	35	120p

Beautiful Mini Radial Low Voltage
Matsushita only

uFd	V	
10	16	6p
22	10	6p
22	16	7p
47	10	7p
47	16	8p
100	10	9p
100	16	10p
220	10	11p
220	16	12p
470	10	17p
470	16	18p
1000	10	20p
1000	16	24p
2200	10	34p
2200	16	44p

Cermet 20 Turn Precision Presets
50Ω, 100Ω, 200Ω, 500Ω, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 250K, 500K
89p each

1000vdc Caps (300VAC) Axial

1nF, 2.2nF	23p
4.7nF, 6.8nF	26p
10nF	28p
22nF, 33nF	37p
47nF	45p
100nF	48p
220nF	74p
470nF	1.10

1500VDC Caps (300VAC) Axial

1nF, 2.2nF	30p
3.3nF, 4.7nF	32p

2000VDC Axial
100nF 20% 76p

Ceramic Hi Volt Disc Capacitors

100p/1KV	20p
100p/2KV	24p
100p/3KV	26p
100p 4KV	28p
220p/6KV	30p
470p/2KV	27p
470p/6KV	32p
1n/2KV	28p
1n/6KV	32p
2n2/2KV	30p
2n2/4KV	32p
2n2/5KV	33p
3n3/2KV	31p
3n3/4KV	32p
4n7/4KV	33p

400V Polyester Capacitors

1nF, 1.5nF, 2.2nF	18p
3.3nF, 4.7nF, 6.8nF	19p
10nF, 15nF, 22nF	20p
33nF, 47nF, 68nF	22p
100nF, 150nF	25p
220nF	38p
330nF	58p
470nF	66p

ETCH RESIST TRANSFERS
1 Thin lines
2 Thick lines
3 Thin bends
4 Thick bends
5 DIL pads
6 Transistor pads
7. Dots + holes
8 0.1" edge cons.
9. Mixture any sheet of above 35p

Wire & Cable
Prices per metre
Solid Hook up Wire
Any colour 5p

Mains/Speaker Cable (per metre)

Twin 1 amp	14p
Twin 2½ amp	16p
3 Core 2½ amp	18p
3 Core 6 amp	31p
3 Core 13 amp	56p

Solid Multicore

4 Core	33p
8 Core	39p
12 Core	46p
50 Core	1.37

Screened Cable

Single	14p
Stereo	27p
Mini Single	12p
Mini Stereo	15p
4 Core 4 Screens	44p
4 Core 1 Screen	54p
8 Core	61p
12 Core	80p

Aerial Cable

50Ω RG58A	38p
75Ω UHF	36p
75Ω VHF	28p
300Ω Flat	14p

Rainbow Ribbon Cable

10 Way	65p
24 Way	152p
40 Way	210p

PHOTO SENSITIVE PCB
1st Class Epoxy Glass. For better results than spraying. Expose to UV

Single sided	
100 x 160	1.55
100 x 220	1.90
203 x 114	1.85
233 x 220	3.99
Double sided	
100 x 160	1.65
100 x 220	2.15
203 x 114	2.21
233 x 220	4.55
Developer for above (do not use Sodium Hydroxide) 500 ml	2.50

DALO ETCH RESIST PEN
+ spare nib 90p

ANTEX SOLDERING IRONS

C240 (15W)	4.59
X25 (25W)	4.99
Iron stand	1.65
C240 Element	1.99
X25 Element	2.05
Bits C240	
No 2 (Small)	65p
No 3 (Med)	65p
No 6 (Micro)	65p
Bits X25	
No 50 (Small)	65p
No 51 (Med)	65p
No 52 (Lge)	65p

SOLDER
125gms

18 swg	2.95
22 swg	3.10

DIL SOCKETS

Pins	Lo-prof	W Wp
8	8 p	25 p
14	9 p	35 p
16	10 p	40 p
18	16 p	50 p
20	20 p	—
22	22 p	—
24	24 p	70 p
28	28 p	79 p
40	30 p	99 p

TRANSISTORS
Probably the largest retail variety in UK
If you don't see what you want please phone or write as this is not a full list

2N404	1.50
2N914	20p
2N916	39p
2N917	65p
2N918	33p
2N929	36p
2N929A	45p
2N930	20p
2N930A	30p
2N1131	24p
2N1132	25p
2N1302	45p
2N1303	65p
2N1304	60p
2N1306	65p
2N1308	65p
2N3170	58p
2N1420	66p
2N1483	2.95
2N1485	3.47
2N1507	42p
2N1524	58p
2N1702	3.20
2N1711	35p
2N1889	50p
2N1890	50p
2N1893	49p
2N1974	1.50
2N2060	7.14
2N2102	39p
2N2217	39p
2N2218	33p
2N2218A	25p
2N2219	27p
2N2219A	28p
2N2220	22p
2N2221	22p
2N2221A	23p
2N2222	24p
2N2222A	25p
2N2223	2.60
2N2223A	4.15
2N2303	39p
2N2368	25p
2N2369	19p
2N2369	18p
2N2405	88p
2N2410	1.15
2N2411	3.60
2N2412	80p
2N2477	95p
2N2483	25p
2N2484	26p
2N2491	8.00
2N2646	45p
2N2647	88p
2N2714	12p
2N2848	60p
2N2875	2.20
2N2890	1.10
2N2891	2.28
2N2892	3.00
2N2904A	27p
2N2905	28p
2N2905A	29p
2N2906	25p
2N2906A	30p
2N2907	25p
2N2907A	29p
2N2920	3.47
2N2923	25p
2N2924	15p
2N2925	15p
2N2926	10p
2N3010	75p
2N3011	25p
2N3019	50p
2N3053	27p
2N3054	56p

2N3055H	120p
2N3055	60p
2N3107	46p
2N4240	42p
2N3109	48p
2N3232	1.50
2N3250	38p
2N3251	36p
2N3300	60p
2N3301	68p
2N3302	80p
2N3390	38p
2N3391	30p
2N3391A	34p
2N3392	27p
2N3393	24p
2N3394	20p
2N3395	26p
2N3396	26p
2N3397	27p
2N3402	35p
2N3403	50p
2N3404	50p
2N3405	50p
2N3416	24p
2N3417	23p
2N3420	2.50
2N3439	98p
2N3440	80p
2N3441	1.25
2N3442	1.35
2N3442RCA	1.85
2N3444	1.70
2N3445	4.80
2N3446	6.09
2N3447	5.72
2N3448	6.56
2N3468	1.00
2N3512	1.06
2N3553	2.30
2N3563	20p
2N3564	25p
2N3565	20p
2N3566	50p
2N3567	55p
2N3568	50p
2N3569	50p
2N3570	2.54
2N3571	2.19
2N3572	2.06
2N3584	2.76
2N3585	2.99
2N3605	38p
2N3606	28p
2N3607	28p
2N3632	9.88
2N3638	35p
2N3638A	37p
2N3639	36p
2N3641	39p
2N3642	25p
2N3643	15p
2N3644	28p
2N3645	33p
2N3646	28p
2N3662	15p
2N3663	16p
2N3691	18p
2N3692	20p
2N3693	25p
2N3694	30p
2N3702	10p
2N3703	10p
2N3704	10p
2N3705	10p
2N3706	10p
2N3707	10p
2N3708	10p
2N3709	10p
2N3710	10p
2N3711	10p
2N3712	2.00
2N3713	1.38
2N3714	2.98
2N3715	3.31
2N3716	3.60
2N3724	75p
2N3725	85p
2N3730	4.65
2N3732	2.88
2N3734	1.30
2N3725	2.45
2N3738	2.00
2N3740	2.38
2N3741	2.76
2N3766	2.90
2N3767	3.19
2N3771	1.75
2N3772	1.83
2N3773	1.99
2N3779	1.70
2N3789	3.27
2N3790	2.73
2N3791	2.47
2N3792	2.68
2N3749	25p
2N3819	21p
2N3820	38p
2N3821	1.84
2N3822	90p
2N3823	45p
2N3824	1.70
2N3826	78p
2N3827	78p
2N3854	44p
2N3855	30p
2N3855A	40p
2N3856	45p
2N3858	31p
2N3858A	37p
2N3859A	31p
2N3860	31p
2N3866	90p
2N3877A	35p
2N3900	25p
2N3901	30p
2N3902	6.65
2N3903	15p
2N3904	15p
2N3905	15p
2N3906	15p
2N3945	85p
2N3962	30p
2N3964	1.42
2N4030	66p
2N4031	55p
2N4032	65p
2N4036	58p
2N4037	43p
2N4058	10p
2N4059	17p
2N4060	12p
2N4061	10p
2N4062	10p
2N4064	1.15
2N4069	1.00
2N4074	75p
2N4092	98p
2N4093	1.20
2N4121	45p
2N4122	45p
2N4123	21p
2N4124	35p
2N4125	37p
2N4126	27p
2N4220	75p
2N4221	95p
2N4222	97p
2N4223	97p
2N4224	98p
2N4234	45p
2N4236	45p

2N4237	1.21
2N4238	95p
2N4239	1.00
2N4240	3.00
2N4248	15p
2N4249	17p
2N4250	17p
2N4266	45p
2N4275	48p
2N4284	32p
2N4285	35p
2N4287	45p
2N4288	22p
2N4289	15p
2N4290	45p
2N4291	45p
2N4292	45p
2N4294	45p
2N4297	2.50
2N4302	39p
2N4303	40p
2N4304	41p
2N4314	60p
2N4342	68p
2N4347	2.26
2N4351	1.16
2N4400	15p
2N4401	27p
2N4402	30p
2N4403	30p
2N4409	36p
2N4410	42p
2N4427	79p
2N4440	12.58
2N4870	80p
2N4871	55p
2N4888	92p
2N4898	1.29
2N4901	1.69
2N4902	3.52
2N4903	3.24
2N4904	2.75
2N4905	3.25
2N4906	3.42
2N4907	3.20
2N4908	3.70
2N4909	2.90
2N4910	1.95
2N4913	2.59
2N4914	2.69
2N4915	2.95
2N4916	48p
2N4917	47p
2N4918	95p
2N4919	1.28
2N4920	1.34
2N4921	55p
2N4922	69p
2N4923	99p
2N4924	92p
2N4926	95p
2N4927	95p
2N4928	1.59
2N4964	27p
2N4965	25p
2N4966	25p
2N4967	25p
2N4968	25p
2N4969	31p
2N5010	8.50
2N5011	9.37
2N5030	44p
2N5033	48p
2N5036	1.60
2N5036	1.95
2N5039	3.90
2N5086	36p
2N5087	39p
2N5088	37p
2N5089	37p
2N5126	48p
2N5217	38p
2N5128	38p
2N5129	30p
2N5130	37p
2N5131	22p
2N5133	22p
2N5135	38p
2N5136	38p
2N5137	23p
2N5138	18p
2N5139	48p
2N5140	25p
2N5141	25p
2N5143	25p
2N5172	15p
2N5175	58p
2N5179	39p
2N5180	43p
2N5183	1.00
2N5184	1.10
2N5188	1.15
2N5189	1.00
2N5190	68p
2N5191	70p
2N5193	90p
2N5194	79p
2N5209	24p
2N5210	25p
2N5219	25p
2N5220	15p
2N5221	25p
2N5222	28p
2N5223	15p
2N5224	38p
2N5225	25p
2N5226	25p
2N5227	25p
2N5232	30p
2N5232A	32p
2N5245	37p
2N5246	40p
2N5247	45p
2N5248	46p
2N5249	48p
2N5266	2.88
2N5293	98p
2N5294	1.28
2N5295	1.37
2N5296	1.28
2N5298	1.37
2N5302	3.20
2N5303	3.80
2N5305	25p
2N5306	37p
2N5307	40p
2N5308	25p
2N5354	19p
2N5355	19p
2N5358	73p
2N5366	25p
2N5367	28p
2N5401	35p
2N5415	1.10
2N5416	1.54
2N5447	16p
2N5448	19p
2N5449	21p
2N5450	23p
2N5451	25p
2N5457	29p
2N5458	29p
2N5459	29p
2N5460	72p
2N5461	60p
2N5462	80p
2N5484	40p
2N5485	29p
2N5490	1.37
2N5492	1.56
2N5494	1.37
2N5496	1.59

2N5543	5.00
2N5551	37p
2N5640	45p
2N5654	35p
2N5786	80p
2N5813	23p
2N5884	7.28
2N6027	30p
2N6030	6.60
2N6082	11.99
2N6099	1.20
2N6101	1.30
2N6109	1.15
2N6111	1.00
2N6121	54p
2N6122	56p
2N6123	59p
2N6124	56p
2N6125	59p
2N6126	71p
2N6129	79p
2N6130	93p
2N6131	98p
2N6132	83p
2N6133	1.14
2N6134	1.36
2N6253	1.45
2N6254	1.55
2SC1306	95p
2SC2078	1.70
2SJ49	3.98
2SJ50	4.45
2SJ82	4.29
2SK134	3.98
2SK135	4.45
2SK226	4.29
3N139	3.30
3N140	1.07
3N143	2.85
3N152	3.00
3N153	2.47
3N154	2.56
3N200	6.93
3N201	2.98
40280	2.00
40290	2.00
40309	1.80
40311	97p
40312	1.64
40313	1.89
40315	1.94
40316	95p
40324	1.86
40325	2.46
40326	1.98
40346	1.30
40347	89p
40348	1.95
40360	60p
40361	67p
40362	67p
40363	2.22
40364	2.90
40372	1.80
40373	2.60
40374	2.84
40389	1.24
40390	2.72
40392	1.20
40394	1.10
40394	1.70
40406	1.39
40407	75p
40408	1.59
40410	1.80
40411	2.85
40412	90p
40422	2.95
40467A	1.29
40513	1.75
40537	96p
49543	1.60
40594	99p
40595	99p
40600	2.58
40601	2.36
40602	1.68
40603	1.09
40604	1.85
40608	2.44
40622	1.45
40625	1.60
40626	3.20
40631	1.90
40631	2.12
40635	1.35
40637	2.00
40643	1.80
40673	70p
40822	1.80
40871	79p
40872	79p
AC125	49p
AC126	25p
AC127	25p
AC128	35p
AC132	39p
AC151	51p
AC152	45p
AC153	55p
AC153K	64p
AC176	27p
AC176K	37p
AC187	25p
AC187K	28p
AC188	25p
AC188K	40p
ACY17	1.50
ACY18	90p
ACY20	75p
ACY21	75p
ACY22	75p
ACY28	75p
ACY44	98p
AD136	6.75
AD145	1.65
AD149	79p
AD150	1.31
AD161	39p
AD162	39p
AF106	75p
AF109	75p
AF114	65p
AF117	70p
AF118	89p
AF124	72p
AF125	72p
AF126	72p
AF139	53p
AF170	88p
AF172	88p
AF178	88p
AF200	65p
AF201	75p
AF239	1.24
AF240	1.00
AF279B	75p
AF279G	75p
AL102	3.49
AU110	2.20
AU113	2.30
BC107	10p
BC107A	12p
BC107B	12p
BC108	10p
BC108A	12p
BC108B	12p
BC108C	14p
BC109	10p
BC109B	12p
BC109C	12p

BC113	30p
BC114	19p
BC115	22p
BC116	32p
BC116A	37p
BC117	19p
BC118	19p
BC119	38p
BC121	82p
BC123	82p
BC125	37p
BC132	39p
BC134	36p
BC135	45p
BC136	45p
BC137	39p
BC138	55p
BC140	29p
BC141	37p
BC142	29p
BC143	34p
BC147	10p
BC147A	10p
BC147B	10p
BC147C	20p
BC148	10p
BC148A	12p
BC148B	13p
BC148C	13p
BC149	10p
BC149B	12p
BC149C	13p
BC152	35p
BC153	23p
BC154	27p
BC157	11p
BC157A	12p
BC157B	13p
BC158	10p
BC158A	12p
BC158B	13p
BC159	11p
BC159A	12p
BC159B	13p
BC159C	18p
BC160	42p
BC161	48p
BC167	10p
BC167A	10p
BC167B	13p
BC168	10p
BC168B	10p
BC168C	10p
BC169	10p
BC169B	10p
BC169C	10p
BC170	15p
BC170A	17p
BC170B	17p
BC170C	18p
BC171	12p
BC171A	15p
BC171B	15p
BC172	12p
BC172A	15p
BC172B	15p
BC172C	16p
BC173	11p
BC173B	16p
BC173C	16p
BC174	21p
BC174A	24p
BC174B	24p
BC175	75p
BC177	16p
BC177A	25p
BC177B	26p
BC178	16p
BC178A	24p
BC178B	25p
BC179	20p
BC179A	25p
BC179B	25p
BC179C	27p
BC182	10p
BC182A	12p
BC182B	13p
BC182L	10p
BC182LA	13p
BC182LB	14p
BC183	10p
BC183A	11p
BC183B	12p
BC183C	13p
BC183L	10p
BC183LA	13p
BC183LB	13p
BC183LC	14p
BC184	10p
BC184B	12p
BC184C	13p
BC184L	10p
BC184LB	13p
BC184LC	14p
BC196	24p
BC187	24p
BC204	29p
BC205	29p
BC206	29p
BC207	29p
BC208	29p
BC209	29p
BC212	10p
BC212A	12p
BC212B	13p
BC212L	10p
BC212LA	13p
BC212LB	14p
BC213	10p
BC213A	11p
BC213B	12p
BC213C	13p
BC213L	10p
BC213LB	13p
BC213LC	14p
BC214	10p
BC214B	12p
BC214C	13p
BC214L	10p
BC214LB	13p
BC214LC	14p
BC237	14p
BC237A	16p
BC237B	17p
BC237C	18p
BC238	14p
BC238A	15p
BC238B	16p
BC238C	17p
BC239	15p
BC239A	16p
BC239B	17p
BC239C	18p
BC250	22p
BC250A	23p
BC250B	24p
BC250C	25p
BC251	25p
BC251A	26p
BC251B	27p
BC251C	28p
BC252	22p
BC252B	23p
BC252C	24p
BC253	22p
BC253B	23p
BC253C	24p
BC256	25p
BC256A	26p
BC256B	27p
BC257	26p
BC257A	27p
BC258	24p

BC258A	25p
BC258B	26p
BC259	25p
BC259B	26p
BC259C	27p
BC260	30p
BC260B	32p
BC260C	33p
BC261	33p
BC261A	34p
BC261B	35p
BC261C	36p
BC262	31p
BC262A	32p
BC262B	33p
BC262C	34p
BC263	30p
BC263B	31p
BC263C	32p
BC264	40p
BC264B	42p
BC266	35p
BC266A	36p
BC266B	37p
BC300	45p
BC301	44p
BC302	43p
BC303	47p
BC304	46p
BC307	13p
BC307A	14p
BC307B	15p
BC308	12p
BC308A	13p
BC308B	14p
BC309	14p
BC309A	15p
BC309B	16p
BC309C	17p
BC317	15p
BC318	15p
BC320	25p
BC321	25p
BC327	14p
BC328	14p
BC337	15p
BC338	15p
BC347	20p
BC350	20p
BC382	30p
BC382L	30p
BC383	30p
BC383L	30p
BC384	30p
BC384L	30p
BC407	30p
BC408	24p
BC409	30p
BC413	25p
BC414	25p
BC415	30p
BC416	30p
BC418	30p
BC440	32p
BC441	33p
BC460	32p
BC461	33p
BC478	29p
BC479	30p
BC516	40p
BC517	40p
BC547	13p
BC547A	14p
BC547B	14p
BC548	12p
BC548A	13p
BC548B	14p
BC548C	15p
BC549	13p
BC549B	14p
BC549C	15p
BC550	30p
BC550C	33p
BC557	15p
BC557A	16p
BC557B	16p
BC558	14p
BC558A	15p
BC558B	16p
BC559	15p
BC559B	16p
BC559C	17p
BC560	32p
BC560	32p
BC560C	34p
BC650	45p
BC651	46p
BCW32R	60p
BCY30A	1.30
BCY31	1.15
BCY31A	1.30
BCY32	1.15
BCY32A	1.30
BCY33	80p
BCY33A	1.00
BCY34	80p
BCY34A	80p
BCY54	1.91
BCY58	32p
BCY59	33p
BCY66	1.80
BCY67	2.00
BCY70	16p
BCY71	16p
BCY72	19p
BCY77	34p
BCY78	22p
BCY79	22p
BCY87	6.60
BCY88	4.90
BCY89	4.10
BCZ10	4.60
BCZ11	4.60
BD115	58p
BD116	2.20
BD121	2.25
BD124	2.28
BD131	44p
BD132	44p
BD135	40p
BD136	40p
BD137	42p
BD138	39p
BD139	39p
BD140	39p
BD142	2.40
BD153	1.25
BD155	1.20
BD157	54p
BD158	55p
BD160	3.80
BD181	1.75
BD182	2.50
BD183	2.70
BD187	1.09
BD201	1.30
BD202	1.39
BD204	1.44
BD220	1.00
BD221	95p
BD223	1.00
BD224	95p
BD232	1.11
BD233	70p
BD234	72p
BD237	98p
BD238	88p
BD239A	57p
BD239C	64p
BD240A	59p
BD240C	73p
BD241A	61p
BD241C	67p

BD242A	65p
BD242C	70p
BD243A	72p
BD143C	85p
BD244A	82p
BC244C	1.00
BD245A	1.14
BD245C	1.30
BD246A	1.20
BD246C	1.50
BC249A	2.00
BD249C	2.31
BD250A	2.11
BD250C	2.46
BD433	79p
BD434	65p
BD435	81p
BD436	81p
BD437	88p
BD438	88p
BD439	90p
BD440	91p
BD441	91p
BD442	93p
BD529	1.20
BD530	1.30
BD535	75p
BD536	75p
BD537	80p
BD538	80p
BD539	80p
BD539C	1.10
BD540	85p
BD540C	1.20
BD675	72p
BD676	77p
BD677	78p
BD678	83p
BD711	1.32
BD712	1.32
BDX14	1.30
BDX18	1.59
BDX32	3.47
BDY10	2.00
BDY11	2.50
BDY17	2.89
BDY23	3.40
BDY25	3.75
BDY38	1.74
BDY54	1.70
BDY55	1.75
BDY56	1.80
BDY57	6.25
BDY58	6.15
BDY60	1.60
BDY61	2.80
BDY62	2.34
BDY92	3.75
BF115	35p
BF119	1.00
BF121	75p
BF123	70p
BF127	80p
BF153	39p
BF154	25p
BF157	58p
BF158	25p
BF159	58p
BF160	55p
BF161	58p
BF163	50p
BF166	57p
BF167	29p
BF170	79p
BF173	25p
BF174	77p
BF177	25p
BF178	30p
BF179	35p
BF180	35p
BF181	36p
BF182	36p
BF183	38p
BF184	36p
BF185	37p
BF194	12p
BF195	12p
BF196	12p
BF197	12p
BF198	15p
BF199	15p
BF200	1.49
BF224J	32p
BF225J	35p
BF240	38p
BF241	38p
BF244A	35p
BF244B	39p
BF245A	
BF245B	51p
BF246	52p
BF246A	
BF246B	51p
BF247A	54p
BF247B	55p
BF254	39p
BF255	42p
BF256A	35p
BF256B	45p
BF256C	62p
BF257	30p
BF258	32p
BF259	35p
BF262	80p
BF263	90p
BF270	65p
BF271	68p
BF273	40p
BF274	40p
BF324	38p
BF336	36p
BF337	28p
BF338	48p
BF355	60p
BF362	85p
BF363	85p
BF457	46p
BF458	56p
BF459	62p
BF469	86p
BF470	86p
BFR39	25p
BFR40	25p
BFR41	25p
BFR79	25p
BFR80	25p
BFR81	25p
BFR90	2.11
BFS28	2.95
BFS61	1.00
BFS98	1.10
BFT19	1.65
BFT19B	1.88
BFT66	2.48
BFW10	1.48
BFW10	1.48
BFW11	1.48
BFW43	2.47
BFW59	1.06
BFW87	1.53
BFW90	1.53
BFX12	1.00
BFX13	91p
BFX19	50p
BFX20	80p
BFX29	26p
BFX30	27p
BFX34	1.00
BFX37	70p
BFX43	70p
BFX68	1.00
BFX84	27p
BFX85	28p

BFX86	28p
BFX87	25p
BFX88	26p
BFX89	1.75
BFY18	48p
BFY19	1.10
BFY37	1.20
BFY39	50p
BFY41	1.16
BFY50	23p
BFY51	23p
BFY52	23p
BFY53	31p
BFY56	31p
BFY56A	68p
BFY75	75p
BFY76	50p
BFY77	80p
BFY78	80p
BFY90	79p
BSV81	1.87
BSW41	95p
BSW67	1.00
BSW70	1.00
BSX19	24p
BSX20	24p
BSX21	40p
BSX27	78p
BSX28	66p
BSX29	34p
BSX39	80p
BSX60	75p
BSX61	80p
BSX76	50p
BSX77	55p
BSY24	77p
BSY25	1.00
BSY26	35p
BSY29	70p
BSY39	47p
BSY54	40p
BSY65	58p
BSY95A	25p
BU104	2.22
BU105	1.70
BU109	3.29
BU126	1.47
BU204	2.25
BU205	1.75
BU206	1.89
BU208	1.98
BU326S	2.35
BU406	1.45
BU407	1.45
BU408	1.35
BU409	1.25
BU500	2.95
BUV20	11.00
BUV21	10.90
BUV23	13.60
BUV24	12.10
BUV25	15.00
BLUX20	17.00
BUY 18S	3.95
E430	4.99
J300	48p
J310	25p
MA8001	45p
MA8002	62p
MA8003	39p
MD7000	2.60
ME0401	25p
ME0402	30p
ME0404	25p
ME0411	35p
ME0412	35p
ME0413	35p
ME0414	48p
ME0461	45p
ME0462	45p
ME1001	45p
ME1002	45p
ME1075	45p
ME1100	45p
ME1120	48p
ME3002	25p
ME4001	45p
ME4002	45p
ME4003	45p
ME4101	25p
ME4101	25p
ME4103	25p
ME4104	25p
ME6001	25p
ME6002	25p
ME6003	25p
ME6101	29p
ME6102	28p
ME8001	47p
ME8002	62p
ME8003	50p
ME9001	56p
ME9002	56p
MFE3004	2.36
MJ400	2.98
MJ420	2.26
MJ430	2.98
MJ440	
MJ481	1.69
MJ491	1.72
MJ802	3.99
MJ900	2.90
MJ901	3.10
MJ1000	2.50
MJ1001	3.00
MJ1800	3.60
MJ2500	2.19
MJ2501	2.25
MJ2955	1.00
MJ3000	2.19
MJ3001	2.25
MJ3701	2.55
MJ4502	3.99
MJE340	53p
MJE370	97p
MJE371	99p
MJE520	92p
MJE521	94p
MJE1090	3.65
MJE1100	3.65
MJE2901	3.65
MJE2955	99p
MJE3055	69p
MP8111	1.00
MP8112	1.39
MP8121	1.35
MP8122	1.40
MP8123	1.16
MP8512	1.59
MPF102	39p
MPF103	29p
MPF104	29p
MPF105	29p
MPF112	59p
MPF121	1.69
MPS3638	27p
MPS3640	40p
MPS4356	60p
MPS6517	47p
MPS6518	47p
MPS6530	37p
MPS6560	32p
MPS6562	32p
MPSA05	23p
MPSA06	25p
MPSA10	28p
MPSA12	29p
MPSA13	48p
MPSA14	46p
MPSA16	30p
MPSA18	65p
MPSA20	48p

MPSA42	49p
MPSA43	49p
MPSA55	28p
MPSA56	30p
MPSA65	40p
MPSA66	47p
MPSA70	45p
MPSA92	39p
MPSA93	39p
MPSL01	42p
MPSL51	48p
MPSU01	84p
MPSU04	1.32
MPSU05	55p
MPSU06	56p
MPSU07	75p
MPSU51	88p
MPSU55	58p
MPSU56	59p
MPSU57	1.20
MRF421	poa
MRF453	poa
MRF454	poa
MRF475	7.55
MRF477	poa
MRF479	poa
MRF604	poa
NKT124	63p
NKT125	49p
NKT126	47p
NKT128	42p
NKT129	40p
NKT135	40p
NKT137	42p
NKT210	42p
NKT215	40p
NKT216	65p
NKT218	44p
NKT219	40p
NKT224	40p
NKT225	40p
NKT229	40p
NKT238	46p
NKT239	44p
NKT240	42p
NKT241	40p
NKT242	40p
NKT243	88p
NKT243	86p
NKT244	40p
NKT254	40p
NKT261	40p
NKT262	40p
NKT271	40p
NKT272	40p
NKT275	40p
NKT281	47p
NKT404	2.68
NKT405	2.80
NKT406	2.50
NKT453	2.40
NKT603F	56p
NKT613F	55p
NKT674F	55p
NKT677F	55p
NKT713	47p
NKT717	52p
NKT734	55p
NKT736	58p
NKT773	40p
NKT781	43p
NKT12329	50p
NKT12429	57p
NKT13329	50p
NKT13429	54p
NKT16229	59p
NKT20329	38p
OC20	2.30
OC22	2.00
OC23	2.00
OC25	2.50
OC28	1.70
OC29	2.35
OC35	2.35
OC41	80p
OC43	70p
OC44	82p
OC70	50p
OC71	50p
OC72	50p
OC82	50p
OC82D	70p
OC83	75p
P346A	58p
R2008B	2.14
R2010B	1.88
SC107	27p
SC108	27p
SC109	27p
TIP29A	29p
TIP29C	38p
TIP30A	35p
TIP30C	38p
TIP31A	33p
TIP31C	34p
TIP32A	38p
TIP32C	42p
TIP33A	65p
TIP33C	78p
TIP34A	74p
TIP34C	88p
TIP35A	1.09
TIP35C	1.28
TIP36A	1.29
TIP36C	1.39
TIP41A	49p
TIP41C	55p
TIP42A	55p
TIP42C	59p
TIP49	1.20
TIP50	1.40
TIP53	1.57
TIP54	1.59
TIP110	74p
TIP112	90p
TIP115	81p
TIP117	96p
TIP120	69p
TIP122	73p
TIP125	1.20
TIP127	1.27
TIP130	1.50
TIP132	1.60
TIP135	1.60
TIP137	1.80
TIP140	1.04
TIP142	1.04
TIP145	1.19
TIP147	1.19
TIP162	4.95
TIP2955	77p
TIP3055	70p
TIS37	62p
TIS43	40p
TIS45	66p
TIS46	66p
TIS47	49p
TIS48	65p
TIS49	66p
TIS50	60p
TIS51	65p
TIS52	70p
TIS53	97p
TIS54	85p
TIS55	68p
TIS58	92p

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Items not fully covered on this list include: **OPTO:** 7 seg LEDs, LCDs, bezelled LEDs, Lamps, Lampholders. **FUSES:** 20 mm, 1¼ inch, slow or quick blow, Fuseholders. **CONNECTORS:** DIL, DIN, Phono, 1 mm, 2 mm, 4 mm, Bulgin, USA, I.E.C. **KNOBS:** Plastic, Aluminium, Anodised, Collet, Pointer. **SWITCHES:** Toggle, Biased, Rocker, Rotary, Slide, DIL, Push. **METERS:** LCD, Analogue, Test and Panel. **TOOLS:** Pliers, Cutters, Strippers, Trimmers, Cable Cutters. And much, much more . . . .
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TIS60	42p
TIS62	44p
TIS64	67p
TIS87	60p
TIS88A	62p
TIS90	28p
TIS91	30p
TIS92	30p
TIS93	54p
VN10KM	80p
VN46AF	84p
VN66AF	85p
ZTX107	10p
ZTX108	10p
ZTX109	12p
ZTX300	13p
ZTX301	15p
ZTX302	15p
ZTX303	23p
ZTX304	15p
ZTX310	35p
ZTX311	32p
ZTX312	35p
ZTX313	36p
ZTX314	24p
ZTX320	35p
ZTX330	35p
ZTX341	28p
ZTX500	14p
ZTX501	14p
ZTX502	14p
ZTX503	17p
ZTX504	24p
ZTX510	34p
ZTX530	24p
ZTX531	25p
ZTX650	45p

DIACS

BR100	40p
ST2	25p

THYRISTORS

Sensitive Gate
Small Signal

2N5060	30p
2N5061	32p
2N5062	35p
2N5063	37p
2N5064	40p
BR101	75p
BRY39	60p
BRY55-100	60p
BRY55-300	67p
BRY56	50p
TIC44	35p
TIC47	50p

4, 8 & 12 Amps
Texas TO220
Suffix: A = 100V
B – 200V
C – 300V
D 400V
M – 600V

4A	TIC106A	46p
	TIC106B	47p
	TIC106C	48p
	TIC106D	59p
	TIC106M	68p
8A	TIC116A	66p
	TIC116B	68p
	TIC116C	71p
	TIC116D	73p
	TIC116M	80p
12A	TIC126A	72p
	TIC126B	72p
	TIC126C	73p
	TIC126D	77p
	TIC126M	95p

SIEMENS THYRISTORS

1 2 amp plastic

Bst B0106 (100V)	60p
Bst B0113 (200V)	70p
Bst B0146 (700V)	1.12

4.7 amp plastic

Bst B0206 (100V)	80p
Bst B0213 (200V)	1.10
Bst B0246 (700V)	2 00

TV Thyristors

2N4444	1.80
BT101-500R	1.40
BT106	1.50
BT116 Use TIC116M	
BT119	1.70
BT120	1.50
BT121	1.30
BT139/600	2.50

TRIACS

Texas 400V
TO220 Case

TIC206D(4A)	66p
TIC225D(6A)	74p
TIC226D(8A)	88p
TIC236D(12A)	1.16
TIC246D(16A)	1.22
TIC253D(20A)	1.90
TIC263D(25A)	2 11

Other Triacs

2N5756 (TO5)	1 44
2N6155 (TO127)	3 39
40432 (Quadrac)	2.23
40486 (TO5)	1.65
40512	2 70
40576 (TO66)	3.33
40842	1.92

DIODES

1N34A	30p
1N821	70p
1N823	92p
1N914	4p
1N916	6p
1N1190	1.47
1N1192	1.75
1N1194	1.65
1N1194A	1.80
1N1196A	2.41
1N1198A	2.65
1N1201A	97p
1N1204A	1.00
1N1206	1.20
1N3063	36p
1N3065	48p
1N3492	1.85
1N3493	2.20
1N3493R	2.20
1N3602	36p
1N3604	46p
1N3766	3.00
1N3768	4.50
1N3768R	4.50
1N4001	4p
1N4002	4½p
1N4003	5p
1N4004	5½p
1N4005	6p
1N4006	6½p
1N4007	7p
1N4009	20p
1N4148	6p
1N4150	18p
1N4448	22p
1N4517	22p
1N5172	30p
1N5176	94p
1N5400	12p
1N5401	13p
1N5492	14p
1N5403	15p
1N5404	16p
1N5405	17p
1N5406	18p
1N5407	19p
1N5408	20p
1N5024	52p
1N5625	60p
1N5626	62p
1N5627	68p
1S44	10p
1S131	40p
1S134	56p
1S421	1.00
1S421R	1.00
1S940	10p
1S941	11p
1S961	22p
AA119	28p
AA129	57p
AA144	25p
AAY30	44p
AAY33	46p
AAZ17	27p
BA100	22p
BA102	25p
BA115	25p
BA133	40p
BA138	30p
BA142	20p
BA144	15p
BA155	15p
BA156	38p
BA182	40p
BA201	18p
BA202	26p
BA316	25p
BA317	25p
BA318	30p
BAV10	16p
BAV19	15p
BAV20	15p
BAV49	15p
BAX13	10p
BAX16	11p
BAY38	20p
BAY44	15p
BAY93	10p
BB103B	70p
BB103G	70p
BB104B	80p
BB104G	80p
BB105	52p
BB105A	57p
BB105B	58p
BB109G	65p
BY126	20p
BY127	22p
BY134	52p
BY182	1.26
BY188A	65p
BY206	36p
BY207	36p
BY223	1.56
BY297	48p
BY299	55p
BYW11-800	1.40
BYW11-1000	2.00
BYW12-100	1.30
BYW12-200	1.40
BYW12-400	2.00
BYX10	36p
BYX50-200R	2.00
BYX55-350	62p
BYX71-350	1.10
BYX71-600	1.52
ITT33	15p
ITT44	10p
ITT921	10p
ITT923	15p
ITT2002	27p
MZ2361	1.80
OA10	70p
OA47	20p
OA90	10p
OA91	10p
OA95	20p
OA200	20p
OA202	20p
RAS508AF	75p
SPD9000	75p
SPD9002	95p

BRIDGE RECTIFIERS

(PIV shown in brackets)

1 amp type

W01 (100)	20p
W02 (200)	26p
W04 (400)	28p
W08 (800)	40p

2 amp type
Square with hole

S01 (100)	37p
S02 (200)	40p
S04 (400)	40p
S08 (800)	55p

6 amp type
Square with hole

PW01 (100)	50p
PW02 (200)	78p
PW04 (400)	85p
PW06 (600)	90p

25 amp type
Metal clad with hole

K01 (100)	2.20
K02 (200)	2.30
K04 (400)	2.80
K06 (600)	3.40

Proprietary Bridges

B40C1500	1.20
B80C3700	1.80
BY164	55p
BY179	92p

ZENER DIODES

400-500 mW
E24 Series

2 4-47 V	8p

1 3 Watt
E24 Series

3.3-82 V	15p

2 5 Watt
E24 Series

7.5 75V	1.10

5W wire ended following voltages only 3V3, 3V6, 4V3, 4V7, 5V6, 7V5, 8V2, 8V7, 9V1, 10V, 12V, 20V, 33V, 51V, 62V, 68V	1.25
10W Pos. Stud Following voltages only 7V5, 13, 18, 20, 24, 27, 30, 33, 68, 82, 91, 100, 110	1.25
20W Pos Stud (BZY93 series) E24 values 7V5-75V	2.00

OPTO ELECTRONICS

2N5777	45p
2N5778	60p
2N5779	70p
4N25	1 10
BP100	1.40
BP104	1.00
BPX25	2 47
BPX29	2 47
BPX48	6 76
BPX60	4 75
BPX61	3.48
BPX63	2.93
BPX79	4.60
BPX86	4.15
CQX13	40p
CQX23	53p
CQX33	48p
LD30A	15p
LD36A	18p
LD37A	18p
LD52A	12p
LD56A	15p
LD57A	15p
LD52C	30p
LD56C	30p
LD57C	30p
LD80A	18p
LD86A	22p
LD87A	22p
LD242	75p
LD271	40p
LD461	25p
LD466	1.45
LD468	1.65
LD471	27p
LD476	1 20
LD478	1.45
LD479	1 65
LD481	27p
LD486	1.25
LD488	1 70
LD489	1 89
LD599	81p
ORP12	1 20
RPY60	2 65
RPY63	2.65
TIL32	71p
TIL63	1 95
TIL64	1.95
TIL65	2 25
TIL66	2 30
TIL67	2 35
TIL78	60p
TIL81	1 60
TIL99	1.35
TIL100	79p
TIL116	1.10
TIL138	2.40
TIL139	2.40
TIL209	9p
TIL211	14p
TIL212	14p
TIL224	32p
TIL228	42p
TIL312	1.65
TIL313	1.65
TIL401	3.50
TIL403	3.80
TIL406	4.10

NEW OPTO DEVICES

inc. Superbright see below

SWITCHES

DIL SPST

4 way	67p
6 way	82p
8 way	90p
10 way	1.40

Toggle (mini)

SPST	49p
SPDT	59p
DPDT	69p
DPDT C off	79p
4PDT	2.75

D. CONNECTORS 25 WAY

Solder type

Male	1.60
Fmale	2.05

Angled PCB

Male	2.45
Fmale	2.90
Covers	99p

NEW OPTO DEVICES

New LEDs
Now in stock
R = red
G = green
Y = yellow
Large diffused

	1+	50+
R5D	9p	7p
G5D	15p	12p
Y5D	15p	12p

Small diffused

R2D	8p	6p
G2D	12p	10p
Y2D	12p	10p

Micro 0 1"

R1D	25p	22p
G1D	27p	25p
Y1D	27p	25p

Large clear

R5C	12p	10p
G5C	17p	13p
Y5C	17p	13p

Super bright
Large (100 times brighter)

R5U	38p	29p
G5U	42p	34p
Y5U	42p	34p

Tri colour flat

RGY8	83p	78p

LINEAR ICs

AY1-5050	95p
AY3-8910	3.66
AY3-8912	4.40
AY5-2376	5.89
CA3000	4.80
CA3001	4.95
CA3002	4.60
CA3005	3.15
CA3007	4.92
CA3010	1.30
CA3012	1.75
CA3013	4.12
CA3014	2.35
CA3015	2.62
CA3018	75p
CA3018A	2.00
CA3020	2.00
CA3020A	3.90
CA3021	3.20
CA3022	3 12
CA3026	1.52
CA2028A	95p
CA3028B	1.99
CA3029	1.44
CA3030A	2.97
CA3033	5.44
CA3034	5.18
CA3036	2.75
CA3039	1.50
CA3041	3.47
CA3042	3.47
CA3043	2.75
CA3046	69p
CA3047	4.60
CA3048	2.15
CA3049	3.21
CA3050	4.11
CA3051	3.80
CA3052	2.92
CA3053	1.00
CA3054	1.66
CA3059	2.80
CA3060	4.09
CA3062	13.84
CA3065E	4.62
CA3068	4.23
CA3070	3.20
CA3071	3.30
CA3075	2.10
CA3076	3.42
CA3078T	2.25
CA3080	1.89
CA3080A	3.95
CA3060E	70p
CA3081	1.90
CA3085	1.35
CA3086	48p
CA3089E	1.95
CA3090AQ	3.70
CA3130E	87p
CA3130T	1.80
CA3140E	39p
CA3140T	85p
HA1366W	2.40
HA1388	2.54
ICL7106	6.85
ICL7107	9.50
ICL8038	2.99
ICM7555	80p
LC7120	3.20
LC7130	3.20
LC7137	4.00
LF347	1.50
LF351	47p
LF353	92p
LF355	83p
LF356	92p
LF357	1.09
LF13201	2.99
LF13331	3.30
LF13741H	68p
LF13741N	59p
LM10CH	4.25
LM11CH	4.50
LM114	6.75
LM137K	11.52
LM301AH	1.00
LM301AN	25p
LM305AH	2.90
LM305H	88p
LM307H	1.05
LM307N	45p
LM308AH	3.15
LM308AN	2.14
LM308H	95p
LM308N	88p
LM309K	2.80
LM310H	1.95
LM310N	1.89
LM311H	1.04
LM311N	70p
LM317K	2.80
LM317MP	1.04
LM318H	2.40
LM318N	1.49
LM319H	2.48
LM319N	2.10
LM320 – See 79XX Series Volt	

Regulators

LM324N	29p
LM337K	4.75
LM337MP	1.65
LM337T	1.99
LM339AN	1.60
LM339N	47p
LM340 – See 78XX Series Volt	

Regulators

LM345K	3.60
LM348N	62p
LM349N	1.09
LM350K	4.60
LM359N	1.44
LM360N	3.88
LM376N	65p
LM377N	1.69
LM378N	3.40
LM379S	4.79
LM380N14	75p
LM380N8	1.50
LM381AN	2.26
LM381N	1.40
LM382N	1.12
LM383T	3.40
LM384N	1.40
LM386N1	88p
LM386N4	1.20
LM388N	2.43
LM391N60	1.70
LM391N80	1.93
LM392N	76p
LM393N	96p
LM394H	3.80
LM396K	13.52
LM709N8	64p
LM709CH	1.00
LM710CH	89p
LM710CN	52p
LM711CH	1.38
LM711CN	70p
LM723CH	1.21
LM723CN	40p
LM725CH	3.40
LM725CN	3.19
LM733CN	69p
LM741CH	96p
LM741CN	15p
LM741CN14	80p
LM747CN	69p
LM748CH	1.00
LM748CN	35p
LM1303N	1.20
LM1304N	2.50
LM1305N	3.10
LM1307N	2.75
LM1310N	1.45
LM1330N	2.26
LM1458	44p
LM1496	1.08
LM1800	3.24
LM1801	2.99
LM1812	8.00
LM1818	4.00
LM1820	2.15
LM1828	4.79
LM1830	2.44
LM1845	4.12
LM1848	2.89
LM1850	2.75
LM1871	3.25
LM1872	4.39
LM1886	7.44
LM1889	3.77
LM2907N	2.75
LM2907NB	2.60
LM2917N	1.89
LM2917N8	1.89
LM3524	6.77
LM3301	1.60
LM3302	74p
LM3401	65p
LM3404	75p
LM3405	1.45
LM3900	48p
LM3905	1.25
LM3909	79p
LM3911	1.20
LM3914	2.50
LM3915	2.50
LM3916	2.50
LM4250CH	2.63
LM4250N	2.39
LM13600	1.09
MB3712	1.99
MB3756	3.80
MB8719	7.95
M53200	8.54
MC1303= LM1303N	
MC1304= LM1304N	
MC1305= LM1305N	
MC1307= LM1307N	
MC1310= LM13010N	
MC1330= LM1330N	
MC1352	1.75
MC1456	1.80
MC1458= LM1458	
MC1466L	6.77
MC1495L	3.75
MC1496= LM1496	
MC3340	1.45
MC3401= LM3401	
MC3403= LM3403	
MC3405= LM3405	
NE531N	1.36
NE540L	4.95
NE543N	2.50
NE544N	1.80
NE555	16p
NE556	45p
NE558	1.89
NE560	3.25
NE565	1.18
NE566	1.49
NE567	1.37
NE570	4.01
NE571	3.99
NE5534	95p
OM335	7.20
PLL02A	4.95
PLL03A	12.75
RC4136	59p
RC4194	3.95
RC4195	2.95
S556B	2.59
SAD1024A	8.49
SAS560	2.59
SAS570	2.59
SAS580	2.95
SAS590	2.95
SFF96364	7.99
SL470	3.47
SL490	3.47
SL610C	4.00
SL611C	4.00
SL612C	4.00
SL620C	6.00
SL621C	6.00
SL623C	10.00
SL630C	6.00
SL640C	6.00
SL641C	6.00
SN76008	3.90
SN76018	3.90
SN76003N	2.95
SN76013N	2.95
SN7023N= SN76033N	
SN76033N	2.95
SN76110	2.25
SN76115	2.65
SN76116	2.75
SN76226	3.45
SN76228	2.90
SN76477	4.49
SN76530	1.80
SN76550	80p
SN 76666	2.90
SO41P	1.95
SO42P	1.95
TA7204	1.99
TA7205	89p
TA7222	1.45
TA7310	1.49
TAA263	3.88
TAA300	3.95
TAA320	2.05
TAA350	3.60
TAA521	1.50
TAA522	2.47
TAA550	73p
TAA560	2.35
TAA570	2.35
TAA621AX1	2.75
TAA661A	2.50
TAA661B	2.50
TAA700	2.60
TAA930	2.50
TAA930B	2.63
TAA970	2.45
TAA991D	2.45
TAD100	2.00
TBA120AS	69p
TBA331	1.50
TBA341	2.05
TBA395	1.65
TBA396	1.50
TBA450	1.95
TBA460	1.53
TBA500	2.97
TBA500Q	3.11
TBA510	2.95
TBA510Q	3.05
TBA520	2.57
TBA520Q	2.75
TBA530	2.55
TBA530Q	2.76
TBA540	2.72
TBA540Q	2.74
TBA550	3.25
TBA550Q	3.27
TBA560C	2.87
TBA570	2.37
TBA570Q	2.48
TBA581	3.11
TBA641	3.00
TBA651	1.90
TBA673	4.15
TBA700	2.38
TBA700Q	2.47
TBA720AQ	2.60
TBA750	2.25
TBA750Q	2.46
TBA790A	2.11
TBA800	78p
TBA810	95p
TBA820	75p
TBA820M	75p
TBA920	1.95
TBA920Q	1.97
TBA950	2.25
TBA990	2.65
TBA990Q	2.74
TCA105	3.00
TCA160C	2.67
TCA210	2.75
TCA220	3.44
TCA270	2.44
TCA440	2.20
TCA450	2.65
TCA640	4.15
TCA650	4.15
TCA660B	4.15
TCA730	4.80
TCA740	4.80
TCA750	4.85
TCA760	2.75
TCA800	3.50
TBA800Q	3.60
TCA830S	1.90
TCA910	2.19
TCA940	1.69
TDA1002	3.39
TDA1003	3.94
TDA1004	3.94
TDA1005	3.94
TDA1010A	1.79
TDA1022	4.95
TDA1024	1.19
TDA1034	3.20
TDA2020	2.99
TDA2030	2.85
TDA2522	4.20
TDA2530	3.30
TDA2540	4.10
TDA2541	4.10
TDA2560	4.10
TDA2571	4.40
TDA2581	3.75
TDA2590	5.20
TDA2591	4.73
TDA2600	6.15
TDA2610	3.90
TDA2611A	2.50
TDA2640	3.64
TDA3000	2.76
TL061	40p
TL062	60p
TL064	99p
TL071	36p
TL072	50p
TL074	1.30
TL081	50p
TL082	75p
TL083	85p
TL084	89p
TL170	49p
TL430	69p
UAA170	1.69
UAA180	1.69
ULN2003	75p
UPC575C2	2.00
UPC1156	2.75
XR2206	2.92
ZNA234E	8.47
ZN414	1.00
ZN419	2.25
ZN1034	1.99
ZTK22	89p
ZTK33	89p

TTL

7400	11p
7401	11p
7402	11p
7403	12p
7404	12p
7405	15p
7406	19p
7407	19p
7408	14p
7409	14p
7410	14p
7411	16p
7412	18p
7413	18p
7414	25p
7416	20p
7417	20p
7420	15p
7421	20p
7422	20p
7423	20p
7425	24p
7426	28p
7427	22p
7428	26p
7430	14p
7432	22p
7433	22p
7437	25p
7438	25p
7440	15p
7441	55p
7442	32p
7443	89p
7444	89p
7445	50p
7446	60p
7447	40p
7448	44p
7450	15p
7451	15p
7453	15p
7454	14p
7460	15p
7470	34p
7472	25p
7473	25p
7474	20p
7475	25p
7476	28p
7480	49p
7481	1.19
7482	68p
7483	38p
7484	69p
7485	60p
7486	20p
7489	2.20
7490	20p
7491	35p
7492	25p
7493	25p
7494	36p
7495	36p
7496	40p
7497	90p
74100	80p
74104	50p
74105	55p
74107	22p
74109	25p
74110	35p
74116	50p
74118	59p
74119	80p
74120	59p
74121	25p
74122	40p
74123	40p
74125	35p
74126	34p
74128	36p
74132	29p
74136	30p
74141	55p
74142	1.99
74143	2.48
74144	2.10
74145	50p
74147	89p
74148	70p
74150	49p
74151	40p
74153	40p
74154	49p
74155	40p
74156	40p
74157	30p
74159	75p
74160	59p
74161	48p
74162	48p
74163	48p
74164	48p
74165	48p
74166	48p
74170	1.25
74172	2.75
74173	59p
74174	59p
74175	49p
74176	39p
74177	45p
74178	79p
74180	40p
74181	1.15
74182	80p
74184	90p
74185	90p
74186	4.69
74188	2.50
74190	48p
74191	48p
74192	45p
74193	45p
74194	45p
74195	46p
74196	45p
74197	48p
74198	83p
74199	83p
74221	53p

74LS TTL

74LS00	11p
74LS01	11p
74LS02	11p
74LS03	12p
74LS04	12p
74LS05	12p
74LS08	12p
74LS10	12p
74LS11	12p
74LS12	12p
74LS13	15p
74LS14	24p
74LS15	12p
74LS20	12p
74LS21	12p
74LS22	12p
64LS27	12p
74LS28	14p
74LS30	12p
74LS32	13p
74LS33	14p
74LS37	14p
74LS38	15p
74LS40	13p
74LS42	28p
74LS47	35p
74LS51	14p
74LS54	14p
74LS55	14p
74LS73	18p
74LS74	18p
74LS75	20p
74LS76	20p
74LS78	18p
74LS80	1.20
74LS83	36p
74LS85	48p
74LS86	16p
74LS90	24p
74LS92	25p
74LS93	24p
74LS95	39p
74LS96	96p
74LS107	20p
74LS109	27p
74LS112	22p
74LS113	22p
74LS114	22p
74LS122	32p
74LS123	36p
74LS124	89p
74LS125	24p
74LS126	25p
74LS132	39p
74LS136	29p
74LS138	32p
74LS139	30p
74LS145	70p
74LS147	1.57
74LS148	75p
74LS151	37p
74LS153	39p
74LS154	79p
74LS155	29p
74LS156	36p
74LS157	27p
74LS158	29p
74LS160	35p
74LS161	35p
74LS162	35p
74LS163	35p
74LS164	40p
74LS165	59p
74LS168	84p
74LS169	85p
74LS170	70p
74LS173	55p
74LS174	45p
74LS175	39p
74LS181	99p
74LS183	1.05
74LS190	36p
74LS191	36p
74LS192	38p
74LS193	37p
74LS194	32p
74LS195	32p
74LS196	45p
74LS197	48p
74LS221	50p
74LS240	55p
74LS241	55p
74LS242	55p
74LS243	55p
74LS244	50p
74LS245	50p
74LS247	50p
74LS248	55p
74LS249	55p
74LS251	30p
74LS253	32p
74LS257	35p
74LS258	35p
74LS259	55p
74LS261	1.35
74LS266	18p
74LS273	60p
74LS275	2.25
74LS279	30p
74LS280	1.60
74LS283	40p
74LS289	4.70
74LS290	45p
74LS293	40p
74LS295	89p
74LS298	89p
74LS299	2.50
74LS323	1.76
74LS324	1.45
74LS325	2.96
74LS326	2.39
74LS327	2.39
74LS347	95p
74LS348	1.00
74LS352	79p
74LS353	79p
74LS362	7.25
74LS365	29p
74LS366	29p
74LS367	29p
74LS368	29p
74LS373	59p
74LS378	58p
74LS386	1.14
74LS390	46p
74LS393	42p
74LS395	89p
74LS396	1.90
74LS398	2.70
74LS399	1.59
74LS445	99p
74LS490	2.20
74LS540	77p
74LS541	99p
74LS640	1.60
74LS641	1.69
74LS643	2.25
74LS644	2.75
74LS669	1.20
74LS670	1.40
74LS673	5.50
74LS674	9.99
74LS688	1.19

74S TTL

74S00	28p
74S02	28p
74S04	28p
74S08	58p
74S20	38p
74S30	60p
74S32	70p
74S40	1.45
74S64	1.02
74S65	1.02
74S74	75p
74S85	2.99
74S86	82p
74S112	75p
74S113	90p
74S124	2.95
74S132	1.09
74S133	60p
74S138	97p
74S139	1.10
74S140	2.50
74S153	7.95
74S157	2.20
74S163	3.00
74S174	2.50
74S175	3.20
74S188	1.40
74S189	1.40
74S194	1.90
74S200	4.50
74S201	2.40
74S225	2.40
74S261	3.00
74S262	8.50
74S287	2.19
74S288	1.99
74S289	1.57
74S301	3.20
74S470	3.25
74S471	6.25
74S473	12.50
74S474	3.99
74S475	7.95
74S571	6.09
74S573	9.00

74H TTL

74H00	1.45
74H01	1.45
74H04	1.55
74H05	1.55
74H10	1.45
74H11	1.45
74H20	1.45
74H21	1.45
74H30	1.45
74H40	1.55
74H51	1.75
74H53	1.65
74H54	1.45
74H55	1.40
74H60	1.70
74H62	1.75

74L TTL

74L02	1.00
74L10	1.70
74L47	3.27
74L74	1.20
74L85	4.20
74L86	1.50
74L93	2.30
74L98	2.99

74 CMOS/TTL

74C00	27p
74C04	29p
74C10	28p
74C14	89p
74C20	28p
74C30	36p
74C42	96p
74C48	1.40
74C73	54p
74C76	57p
74C83	1.74
74C85	1.34
74C86	1.10
74C89	5.95
74C90	1.05
74C93	1.44
74C95	1.00
74C107	60p
74C151	2.55
74C154	4.95
74C157	2.20
74C160	1.54
74C161	1.16
74C162	1.16
74C163	65p
74C164	1.15
74C165	2.00
74C173	98p
74C174	65p
74C175	75p
74C192	89p
74C193	68p
74C194	89p
74C195	70p
74C200	10.00
74C221	1.20
74C901	1.91
74C902	71p
74C903	2.30
74C904	1.84
74C905	10.88
74C907	1.91
74C908	1.87
74C911	9.59
74C912	8.00
74C914	2.88
74C915	1.99
74C918	2.50
74C920D	8.50
74C922	4.50
74C923	5.00
74C925	6.00
74C926	6.58
74C928	6.00
74C929	5.20
74C930J	7.80
74C932	3.12

40 CMOS

4000	10p
4001	10p
4002	11p
4006	49p
4007	15p
4008	32p
4009	24p
4010	10p
4011	10p
4012	15p
4013	20p
4014	46p
4015	58p
4016	20p
4017	32p
4018	45p
4019	26p
4020	44p
4021	39p
4022	48p
4023	12p
4024	32p
4025	12p
4026	79p
4027	20p
4028	29p
4029	29p
4030	14p
4031	1.19
4032	80p
4033	1.20
4034	1.29
4035	44p
4036	2.49
4037	1.13
4038	89p
4039	2.80
4040	46p
4041	40p
4042	39p
4043	39p
4044	41p
4045	89p
4046	44p
4047	39p
4048	39p
4049	22p
4050	23p
4051	44p
4052	49p
4053	49p
4054	79p
4055	83p
4056	89p
4059	4.35
4060	42p
4063	79p
4066	22p
4067	2.49
4068	14p
4069	13p
4070	13p
4071	13p
4072	13p
4073	13p
4075	13p
4076	45p
4077	13p
4078	13p
4081	12p
4082	12p
4085	49p
4086	60p
4089	1.50
4093	20p
4094	69p
4095	66p
4096	90p
4097	2.88
4098	74p
4099	90p

For higher numbers in 40 Series, substitute 74C for 40 prefix eg 40107 = 74C107

45 CMOS

4502	55p
4503	39p
4507	33p
4508	1.19
4510	35p
4511	48p
4512	48p
4514	1.17
4515	1.17
4516	59p
4518	39p
4519	29p
4520	48p
4521	99p
4526	59p
4527	59p
4528	46p
4532	89p
4534	3.98
4536	2.59
4538	65p
4539	89p
4543	56p
4553	2.25
4555	35p
4556	35p
4560	1.49
4566	1.49
4569	1.59
4584	39p
4585	59p

COMPUTER ICs

CPUs

1802	7.00
6502	3.24
6800	2.18
6802	2.40
6809	6.20
8035	3.49
8060	10.90
8080A	2.50
8085A	3.49
8900	57.75
9980	21.00
SCMP1	20.00
Z80A	3.50

MEMORIES

2101	4.00
2111-1	3.00
2114(200ns)	92p
2532	2.98
2564	7.99
2708	2.25
2716 (5v)	2.11
2764	4.25
4027	3.00
4060	9.50
4116(200ns)	75p
4118-3	3.25
4164	4.25
5204	7.50
6116	3.50
6514	3.30
6810	1.15
7489	1.65
74189	4.00
74LS289	3.25
74LS188	2.25
74LS287	3.05
74LS288	2.25

ZERO INSERTION DIL SOCKETS

24pin	4.90
40pin	5.30

LOGIC ICs

inc COMP. SUPPORT

ADC0804	3.95
ADC0816	14.90
ADC0817	10.06
AY5-1013A	3.00
AY5-2376	5.90
ICM7555	80p
INS1671	20.00
INS1771	20.00
INS1792	30.00
MC1466L	6.50
MC1488	55p
MC1489	55p
MC4024	3.25
MC4044	3.25
MK50250	10.00
MK50398	6.35
MM5303	6.25
MM5307	12.75
MM5357	22.50
MM57105	14.00
MM57109	12.00
MM57160	12.00
MM57161	12.00
MM58174	12.00
RO2513LC	6.99
RO2513UC	7.50
SAA5000	3.00
SAA5010	7.10
SAA5012	7.10
SAA5020	5.50
SAA5030	9.00
SAA5040	15.00
SAA5041	15.00
SAA5050	8.50
SAA5052	8.50
TMS6011	3.65
ULN2003A	85p
8T26	99p
8T28	1.20
8T95	89p
8T97	90p
81LS95	80p
81LS96	85p
81LS97	90p
81LS98	85p
6522	3.19
6532	6.95
6821	1.12
6845	6.50
6847	6.50
6850	1.35
6852	2.40
6875	4.85
8131	3.75
8154	9.00
8155	3.50
8212	1.10
8216	1.00
8223	1.80
8224	1.10
8226	2.50
8228	2.50
8238	5.75
8243	2.60
8250	8.40
8251	2.50
8253	3.95
8254	10.00
8255	2.19
8257	4.00
8259	4.00
8279	3.75
8304	4.50
8544	1.50
8601	1.20
8832	2.60
8833	2.35
9097	3.00
9099	3.00
9601	5.50
9062	2.50
Z80ACTC	2.85
Z80ADART	5.50
Z80ADMA	6.75
Z80AP10	2.70
ZN425E8	3.39
ZN426E8	2.97
ZN427E8	5.99
ZN428E8	4.05

VOLTAGE REGULATORS

(See also Linear ICs)

– Positive –

100 mA

78L05A	30p
78L12A	30p
78L15A	30p
78L24A	30p

100 mA TO5

78L05CH	80p
78L12CH	80p
78L15CH	80p
78L24CH	80p

500 mA TO202

7805M	47p
7812M	47p
7815M	47p
7842M	47p

1 Amp TO220

7805T	39p
7812T	39p
7815T	39p
7824T	39p

1.5 Amp TO03

7805K	1.39
7812K	1.39
7815K	1.39
7824K	1.39

– Negative –

100 mA TO92

79L05	59p
79L12	59p
79L15	59p

500 mA TO202

7905M	55p
7912M	55p
7915M	55p
7924M	55p

1 Amp. TO220

7905T	44p
7912T	44p
7915T	44p
7924T	44p

1.5 Amp. TO3

7905K	1.99
7912K	1.99
7915K	1.99
7924K	1.99

– Variable –

L200 (2A Pos)	2.50
LM137K	12.00
LM309K	1.35
LM317K	3.42
LM317MP	95p
LM317T	1.75
LM337K	4.60
LM337MP	1.73
LM337T	1.75
LM345K	3.60
LM350K	4.50
LM396K	13.52

DESOLDERING PUMP

High Quality
High Suction
Aluminium
Anodised with
Screw in Teflon
Nose £4.45
Spare Nose 85p
1,000s SOLD
GREAT VALUE!

GRAPHIC PROCESSOR

EF9365	£36.99
EF9366	£36.99

HEATSINKS CLIP-ON

TO1 (AC128)	18p
TO5 (BFY51)	18p
TO18 (BC109)	18p
TO220 (TIP29)	38p

Many other sinks in stock including power-sinks Please phone

Rechargeable Batteries:
Guaranteed minimum 500 charges

HP2(1.2AH)	2.10
HP2(4AH)	4.75
HP7 (½AH)	99p
HP11(1 2AH)	2.29

Chargers

TYPE H. Adjusted to 6 of any HP type Above	£15.59
TYPE P: PP3	£6.50
TYPE A: HP7 (Up to 4 at a time)	£5.85

QUARTZ CRYSTALS

Please enquire about types not listed

32 768KHz	99p
100KHz	2.49
200KHz	2.79
1 00MHz	2.95
1.008MHz	2.74
2.00MHz	2.24
2.097152MHz	3.50
3.2768MHz	1.50
4.00MHz	1.40
4.194394MHz	2.00
4.433619MHz	1.10
5.00MHz	1.50
6 00MHz	1.50
6.9375MHz	3.50
8 00MHz	1.50
10 00MHz	1.75
18.00MHz	1.99
20.00MHz	1.99
27 648MHz	2.60
48.00MHz	1.75
100 00MHz	2.95
5.5 MHz Ceramic filter	90p

VALVES

DY86/87/802	1.32
ECC82	1.22
ECC83	1.22
ECC84	1.22
EF86	1.80
EL34	2.89
EL84	2.50
KT66	10.75
KT88	12.50
PC900	1.75
PCC84	3.00
PCC85	3.40
PCC89	1.89
PCF86	2.30
PCF201	3.00
PCF801	2.67
PCF802	2.11
PCL82	1.80
PCL85	2.20
PCL86	2.10
PCL805	2.20
PD510	4.95
PFL200	2.99
PL504	2.11
PL508	2.36
PL519	7.75
PL802	4.17
PY88	1.62
PY500A	2.63
6L6	2.59

PLUGS & SOCKETS

UHF PL259 types
Low loss.
superior quality
50Ω

Line plug	45p
Reducer	15p
Round skt	40p
Sqr skt	40p

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Plug	1.10
Socket	1.00
Line skt	1.15

'KEYNECTOR'

Bare Wire Mains Safety Block
£7.95

RELAY (MINI)
4 pole 2 way
75Ω 6 12V
3 amp contacts
£2.80

CANNON TYPE AUDIO PLUGS

(3 PIN XLR)

Male	1.70
Female	1.65

Sockets (Chassis)

Male	1.50
Female	2.35

JACK PLUGS

Huge Discount for quantity please phone

¼" Mono	20p
¼" Stereo	30p
¼" Metal Mono	30p
2½ mm Mono	12p
2½ mm Metal Mono	20p
3½ mm Mono	12p
3½ mm Stereo	35p
3½ mm Metal Mono	20p

JACK SOCKETS

Chassis

¼" Mono	20p
¼" Stereo	25p
2½ mm Mono	15p
3½ mm Mono	15p

Line

¼" Mono	20p
¼" Metal	30p
¼" Stereo	30p
¼" Stereo Metal	40p
3½ mm Mono	15p
3½ mm Mono Line	20p

BOOKS (no VAT)

(Post inc prices)

Towers Transistor Manual (Bible)	10.50
TTL Data	10.95
Data conversion	4.50
Volt Reg Data	3.95
Interface Data	3.95
Memory applic	4.95
Audio/Radio Hbk	4 50
Special function handbook	3 95

COAX (TV)

All Metal

Plug	25p
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3½ DIGIT LCD MULTIMETER

2 amps AC DC
1KV (DC)
750V (AC)
Incredible at
£34 50
(SAE brings specs)

COMTECH ELECTRONICS

TRANSISTORS

BC107B	12p	BC477	23p	BF244C*	20p	TIP32A/B	33p	2N3707	9p
BC108C	12p	BC478	22p	BF245	25p	TIP32C	37p	2N3708	9p
BC109C	13p	BC479	23p	BF256C*	25p	TIP33B	64p	2N3771	170p
BC113/4	15p	BC546	10p	BF257/8	30p	TIP348*	64p	2N3772	170p
BC115/6	16p	BC547B	9p	BF259	35p	TIP41A	46p	2N3773	190p
BC119*	24p	BC548B*	8p	BF336	36p	TIP42A	46p	2N3819	20p
BC139	30p	BC549C	9p	BF337	39p	TIP2955	70p	2N3823	50p
BC140	28p	BC550C	9p	BF338	40p	TIP3055	70p	2N3866	90p
BC141	28p	BC556	10p	BF457	30p	TIS44	20p	2N3903	10p
BC142/3	27p	BC557B	9p	BF458	32p	TIS90	24p	2N3904	10p
BC160	28p	BC558B	8p	BF459	36p	TIS92	20p	2N3905	10p
BC161	32p	BC559C	9p	BFX29	28p	2N1613	30p	2N3906	10p
BC169C	9p	BC560C	9p	BFX30	28p	2N1711	30p	2N4030	30p
BC171B	9p	BCY70	17p	BFX84/5	28p	2N2218	24p	2N4033	30p
BC172C	9p	BCY71	18p	BFX87	27p	2N2218A	25p	2N4037	40p
BC173C	9p	BCY72	15p	BFX88*	23p	2N2219	24p	2N4058	9p
BC177	16p	BD115	50p	BFY50	23p	2N2219A	25p	2N5457	28p
BC178*	16p	BD131	45p	BFY51	20p	2N2221A	24p	2N5458*	27p
BC179	17p	BD132	48p	BFY52	22p	2N2222*	18p	2N5459	24p
BC1828*	8p	BD135/6	30p	BFY53	28p	2N2222A	20p	2N5460	36p
BC183B/C	8p	BD137*	30p	BFY55/6	30p	2N2368	23p	2N5550	18p
BC184B/C	8p	BD138	35p	BSY95A	23p	2N2369A	15p	2N5551	18p
BC212B*	8p	BD139	35p	BU205	140p	2N2484	24p	2N6027*	20p
BC213B/C	8p	BD140	35p	BU206	150p	2N2646	45p	2N6028	20p
BC214B/C	8p	BD204/6	64p	BU208	140p	2N2904	20p		
BC237	6p	BD222	56p	MJ2955	95p	2N2904A	22p		
BC238/9	9p	BD239C	46p	MJE340	48p	2N2905	22p		
BC251	10p	BD240C	48p	MJE520	60p	2N2905A	25p		
BC300*	40p	BD241C	50p	MJE521	65p	2N2906*	20p		
BC 301	36p	BD242C	52p	MJE2955	80p	2N2906A	22p		
BC 302	36p	BD243C	65p	MJE3055	65p	2N2907	23p		
BC 303	36p	BD244C	76p	MSPA05	18p	2N2907A	25p		
BC 304	36p	BF180	39p	MPSA06*	18p	2N3019	37p		
BC307	10p	BF181/2	30p	MPSA12	20p	2N3053*	23p		
BC308/9	10p	BF183/4	30p	MPSA13	20p	2N3054	55p		
BC327	12p	BF185	29p	MPSA55	18p	2N3055	50p		
BC328	12p	BF194	12p	MPSA56	18p	2N3441	110p		
BC337	12p	BF195/6	12p	TIP29A/B	30p	2N3442	120p		
BC338	12p	BF197	12p	TIP29C	33p	2N3702	9p		
BC413C	10p	BF198	10p	TIP30A/B	30p	2N3703	9p		
BC414C	10p	BF199	9p	TIP30C*	35p	2N3704	9p		
BC415C	10p	BF200	40p	TIP31A/B	33p	2N3705	9p		
BC416C	10p	BF224J	14p	TIP31C	37p	2N3706	9p		

SCRs

C106D*	28p
C116D	70p
C126D	90p
2N4443	108p
2N4444	120p
2N5058	23p
2N5061	24p
2N5064	28p

TRIACS

C206D	55p
C225D	60p
C226D	70p
C236D	90p
C246D	98p

LINEAR ICs

CA3089	170p
CA3090AQ	300p
CA3140E	40p
CA3160E	100p
CA3189	245p
CA3240E	110p
LF351*	45p
LF353	80p
LF355	85p
LF356	85p
LF357*	98p
LM301A	25p
LM307N	54p
LM311N	60p
LM318N*	120p
LM324N	40p
LM339N	46p
LM348N*	60p
LM358N	45p
LM380N	68p
LM382N	120p
LM384N	125p
LM386N	65p
LM387N	130p
LM388N	164p
LM389N	150p
LM392N	98p
LM393N*	70p
LM3900	47p
LM711CN	54p
LM741C*	14p
LM747C	50p
LM748C	35p
LM1458	36p
MC1458*	33p
MC1748	35p
MC1496	70p
MC3302	70p
MC3401	65p
MC3403	60p
NE555*	15p
NE556	43p
SN76115	98p
SN76660	90p
TDA2002	95p
TDA2003	120p
TDA2020	240p
TDA2030	200p

SOCKETS

8 pin	7p
14 pin	8p
16 pin	9p
18 pin*	11p
20 pin	14p
22 pin	14p
24 pin*	16p
28 pin	16p
40 pin*	20p

REGULATORS

79L05	30p
78L12	30p
78L15	30p
7805	33p
7812	33p
7815	33p
79L05*	50p
79L12	50p
79L15	50p
7905	40p
7912	50p
7915	50p
LM309K	120p
LM317K	240p
LM317T*	98p
LM723C	35p
78H05* (5V/5A)	540p

BRIDGE RECTIFIERS

1A/50V	18p
1A/100V	20p
1A/200V	22p
1A/400V	24p
1A/600V	28p
1A/800V	32p
3A/50V*	40p
3A/100V	42p
3A/200V	44p
3A/400V	48p
6A/50V	75p
6A/100V	80p
6A/200V	88p
6A/400V	94p

DIODES

AA119	9p
OA47	9p
OA90/1	7p
OA95	8p
OA200	7p
OA202	8p
BAX13*	4p
BAX16	6p
1S44	6p
1N914	3p
1N916	4p
1N4148*	2p
1N4149	4p
1N4001	3p
1N4002/3	4p
1N4004/5	5p
1N4006/7	6p
1N5401	11p
1N5402	12p
1N5403/4	13p
1N5405/6	14p
1N5407	15p
1N5408	16p
6A/100V	28p
6A/200V	30p
6A/400V	35p

LEDs

3mm red*	6p
5mm red	7p
3mm green	9p
5mm green	10p
3mm yellow	10p
5mm yellow	10p
Clips	3p
rectangular stackable	
RED*	10p
GREEN	14p
YELLOW	15p

ZENERS

400mW 2V7-36V	6p
1.3W 3V9-51V	12p

CMOS

4000	10p	4048	32p
4001	10p	4049	20p
4002	10p	4050	20p
4006	48p	4051	42p
4007	13p	4055	68p
4011*	9p	4066	22p
4012	14p	4068	14p
4013	20p	4069	12p
4014	45p	4070	12p
4015	39p	4071	12p
4016	20p	4072	12p
4017	32p	4073	12p
4018	45p	4075	12p
4019	28p	4077	12p
4020	40p	4078	12p
4021	40p	4081	12p
4022	42p	4082	12p
4023	12p	4093	20p
4024	32p	4098	70p
4025	12p	4510	46p
4026	74p	4511	42p
4027	20p	4512	40p
4028	40p	4514	110p
4029	44p	4516	54p
4030	14p	4520	50p
4040	40p	4528	55p
4041	40p	4555	34p
4042	39p	4556	34p
4046	44p	4584	30p

CAPACITORS

Electrolytic (Radial only)

1/63V	6p	1000/25V	32p
2.2/63V	6p	10/16V	6p
4.7/63V	6p	22/16V	6p
10/63V	7p	47/16V	6p
100/63V	20p	100/16V	10p
10/25V	6p	100/10V	6p
22/25V	6p	220/10V	9p
47/25V	9p	470/10V	10p
100/25V	10p	1000/10V	18p
220/25V	15p	2200/10V	35p
470/25V	23p	4700/10V	75p

Tantulum bead

0.1/35V	12p	10/16V	20p
0.22/35V	12p	15/16V	28p
0.47/35V	12p	22/16V	35p
1/35V	12p	47/10V	60p
2.2/25V	16p	68/ 6V	60p
4.7/25V	18p	100/ 6V	80p

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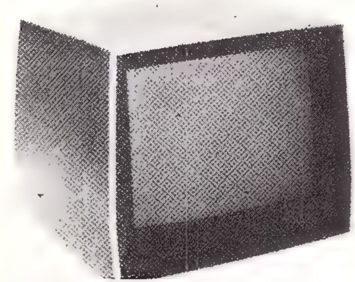

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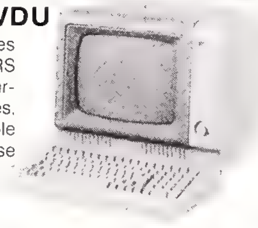

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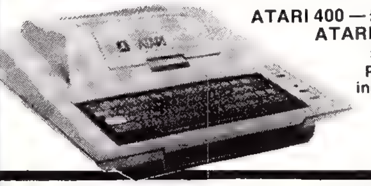

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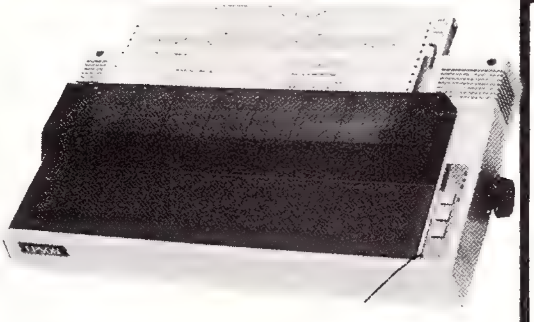

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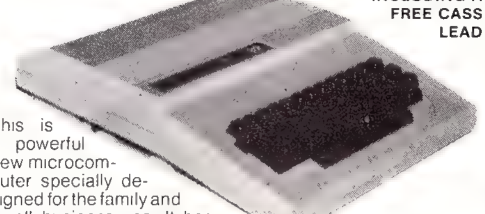

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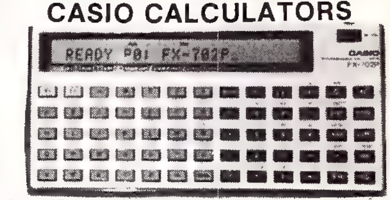

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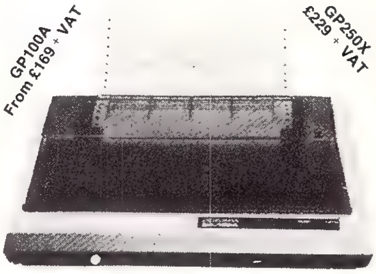

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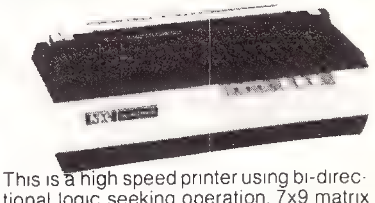

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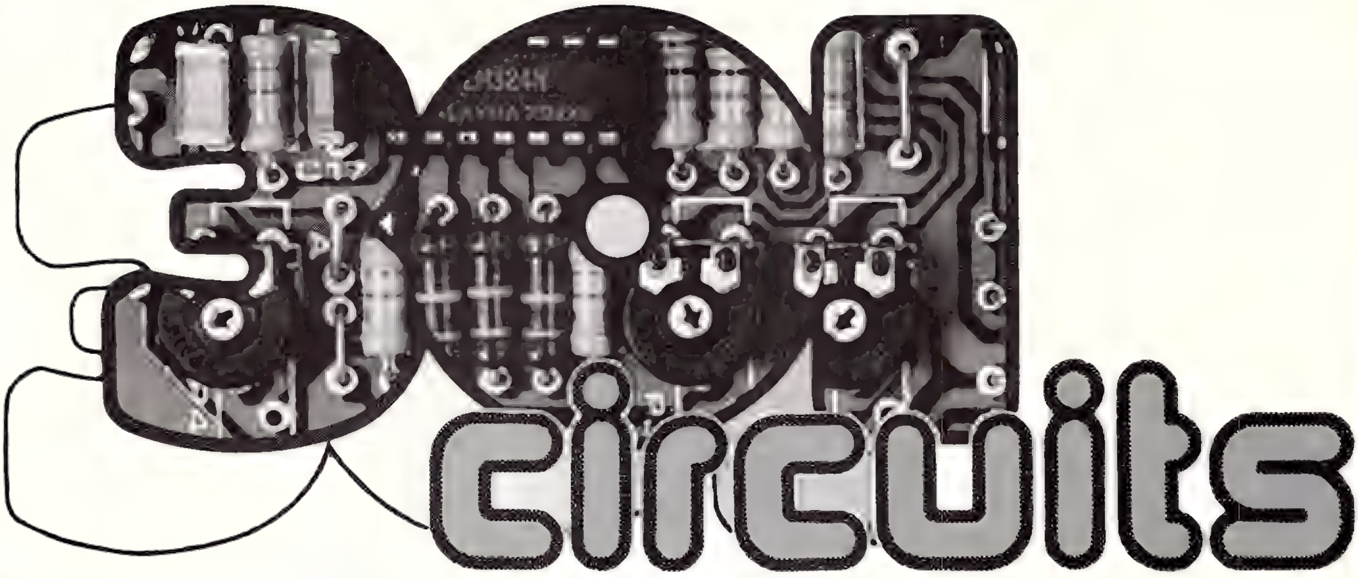

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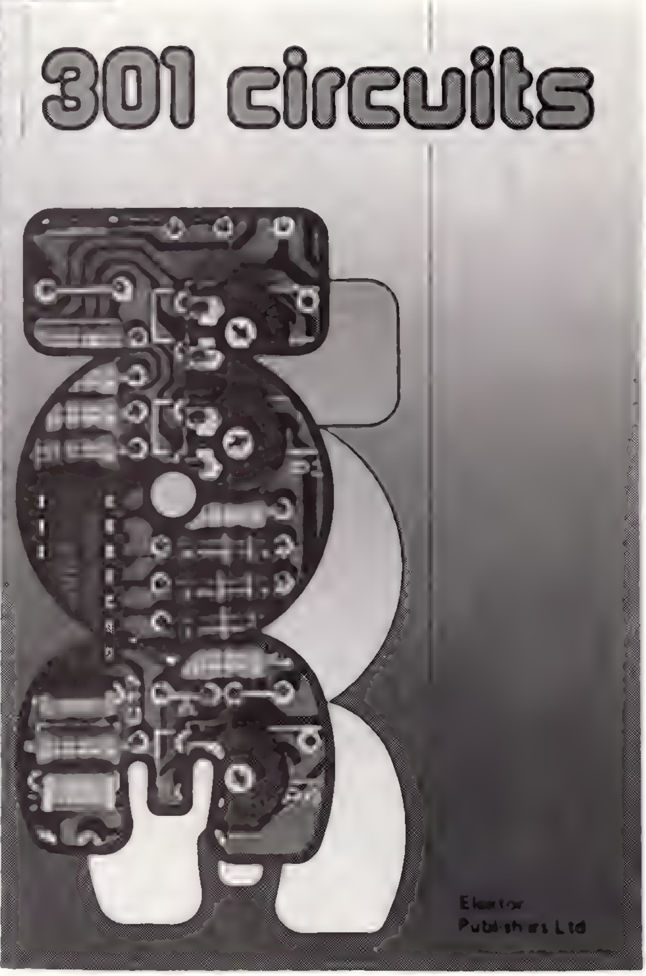

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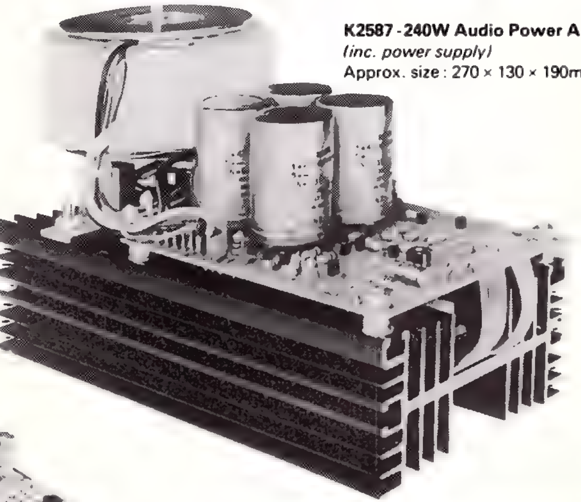

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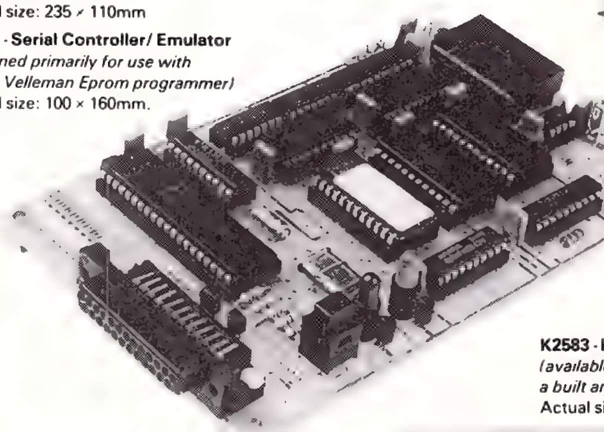

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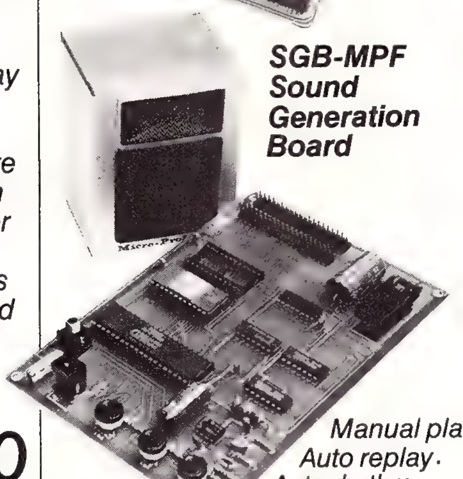

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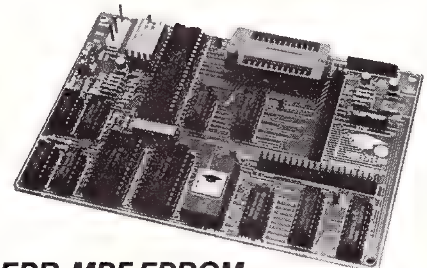

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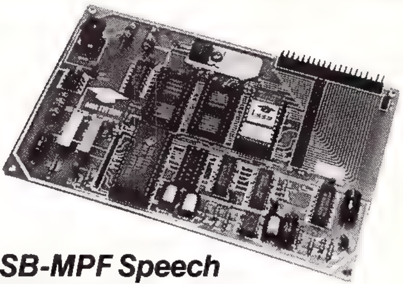

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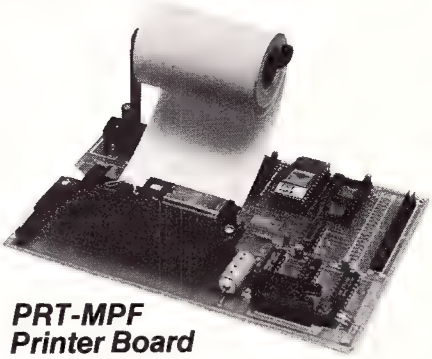

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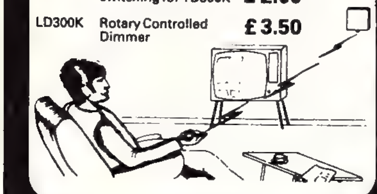

HOME CONTROL CENTRE

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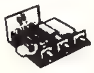

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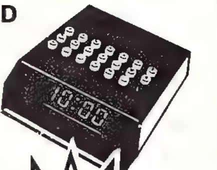

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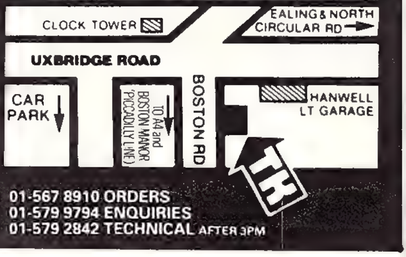
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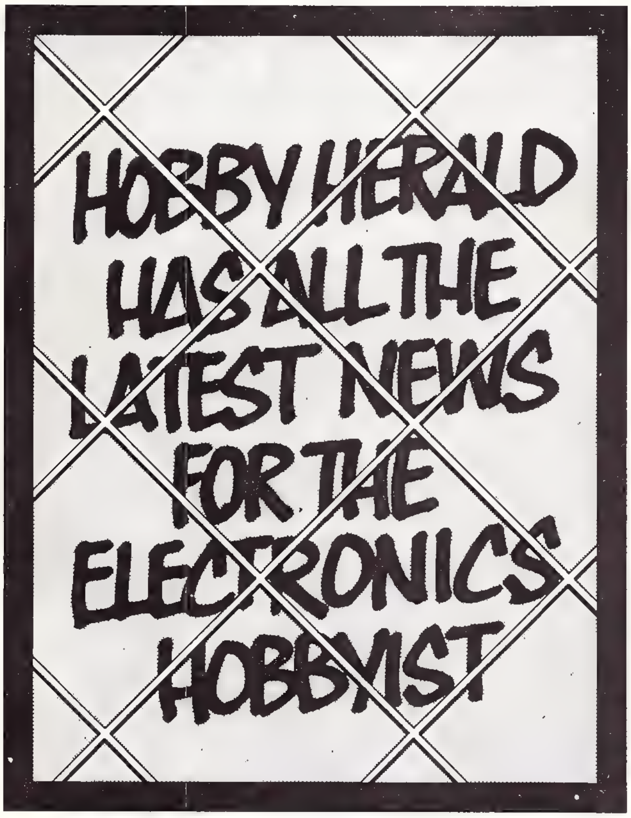

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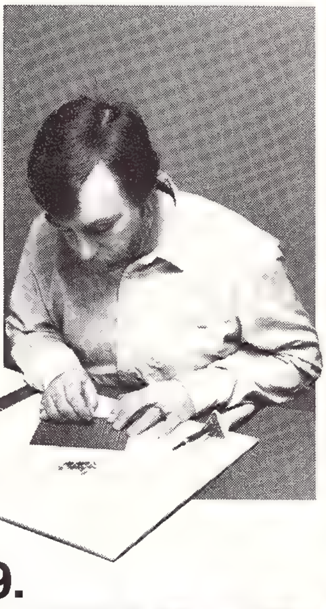

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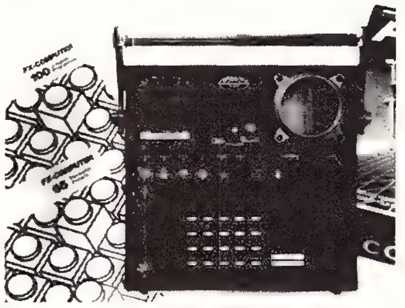

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Raindrops and radar

A new type of radar is able to probe rain to measure the drop-size distribution and rate of rainfall and to distinguish rain from ice cloud. It is an important research tool for the study of climate and of the effect rain may have on high-speed aircraft and radio communication.

Radar has proved a remarkable tool to tell us, rapidly, how rain is distributed over large areas. It also enables us to examine what rain there is well above ground level. While the data it provides is good enough for general weather forecasting, it contains too much ambiguity to be used in estimating the rainfall *rates* in areas of heavy rain. Such information is important to research into flash flooding, crop damage and the attenuation of signals along paths of radio communication.

Ambiguity is there because the rainfall rate, and the amount of radar signal reflected by the rain, may represent a heavy concentration of small drops on the one hand or relatively few but large drops on the other; it is the statistical distribution of drop sizes that governs the relationship between the rainfall rate (or attenuation of a radio wave) and the reflectivity, or echo of the radar signal.

Dual polarisation

To overcome these problems a unique, dual-polarisation radar has been built at Chilbolton, in the South of England, and it is now in use there to map rainfall rates rapidly and accurately in three dimensions. It has a high spatial resolution, that is, an ability to separate reflections by angle and range, and clearly distinguishes between regions of ice clouds and rain. It has a pencil beam only a quarter of a degree wide, made possible by its fully-steerable antenna, 25 metres in diameter. Because radio waves at the very short wavelengths normally used for radar are heavily attenuated by rain, a relatively long operating wavelength of 10 cm has been chosen so that distant rain can be measured accurately without the signal being attenuated by other rain between it and the radar.

1

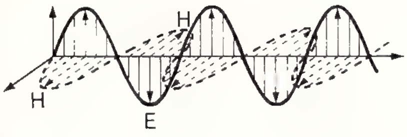


Figure 1. An electromagnetic wave has an electric field E and a magnetic field H, at right angles to each other and to the direction of propagation. In this representation the wave is travelling from left to right. All the E vectors lie in the vertical plane and all the H vectors in the horizontal plane. The plane in which the E vector moves is called the plane of polarisation.

2

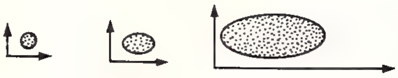


Figure 2. Because large raindrops become distorted as they fall, they give a lot more back-scatter from horizontally polarised waves than they do from waves with vertical polarisation, whereas small drops, remaining almost spherical, back-scatter both types of wave in sensibly equal amounts.

All radio waves comprise an electric field and a magnetic field, oscillating in planes at right angles to each other and to the direction of propagation of the wave. This is shown in figure 1, where E is the electric field and H the magnetic one.

The plane in which E oscillates is called the plane of polarisation of the wave. If it is vertical, the wave is said to be vertically polarised, and if horizontal, it is said to be horizontally polarised. The polarisation can be selected at the aerial system which transmits (and receives) the wave.

The basis of the dual-polarisation technique is that the balance between aerodynamic and surface tension forces on the raindrops causes them to flatten as they fall, whereas small drops tend to remain spherical, as shown in Figure 2. When a region of mainly big drops is illuminated by radar pulses consisting alternately of horizontally and vertically polarised waves, the power back-scattered by the horizontally polarised wave is larger than that when using vertical polarisation. Conversely, for a region of mainly small drops, the back-scattered power is similar for both polarisations.

Research in the USA, suggested that the *differential* reflectivity, which is the ratio of the powers in the back-scattered and vertically polarised waves, is directly related to the mean of the statistical distribution of drop sizes in rain. Being able to measure this differential reflectivity accurately is the big advance which has been made.

Typical data

Figure 3 shows data the radar gave when scanning vertically through rain. In (a) we see a measure of the radar reflectivity of the rain, termed the absolute reflectivity factor Z, measured with horizontal polarisation only. This is precisely what a conventional radar (using single polarisation) would show, assuming that it operated on a 10-cm wavelength and had an antenna 25 metres in diameter, similar to ours. Prominent is the region of high reflectivity extending to a height of 6 km at a range of 35 km.

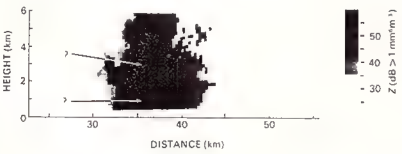
In (b) we see the spatial distribution of the additional *differential* reflectivity Z_{DR} data (using dual polarisation), the rain being sampled at the same time as in (a). The column of high reflectivity at a range of 35 km has a high Z_{DR} (it is greater than 2 dB) up to 2 km above ground, but Z_{DR} is low (the mean value is only 0.13 dB and the standard error 0.27 dB) at heights between 2 and 4.5 km. Such an abrupt change in Z_{DR} is often found close to the 0°C isotherm, and marks the transition from ice particles to water drops. Icy particles that have a low density, for example mixtures of ice and air such as snow, have a low refractive index; unless they are very asymmetric, they show a low Z_{DR}. Furthermore, compact ice particles which have a high density inevitably give low values of Z_{DR} if they are nearly spherical; but if they have an irregular shape they are likely to tumble at random and they also show low Z_{DR}.

Polarisation switch

Our fast switching system to polarise the radar pulses in the appropriate

3

(a) Single polarization radar data



(b) Additional dual-polarization data

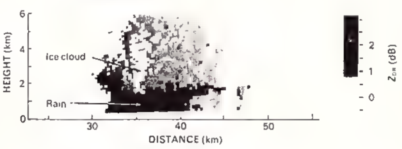


Figure 3. These vertical scans of the radar beam give a comparison of (a) data obtained using single polarisation and (b) data from dual polarisation. The information about ice cloud and rain below it was not resolved in (a).

way is based on a rapidly-rotating chopping vane, as shown in figure 4. Pulses from the transmitter arrive at a T-junction in the waveguide, from which they are passed alternately by open windows in the vane to one or other of two discrete pathways shown as vertical and horizontal polarisation arms; the windows open in synchronism with the generation of the pulses.

The paths merge again at a turnstile polariser, which is a sort of waveguide 'cross-roads'. Two of the four 'roads' are short stubs of waveguide, one of which is half-a-wavelength long and the other only a quarter-wavelength. The ends of the stubs are closed, so energy seeking to travel along them is reflected back to the junction. But, because of the difference in stub lengths, the waves arrive back in such a way that, when the energy recombines, all of it becomes directed into a circular waveguide leading to the aerial system, one pulse being vertically polarised and the next one horizontally polarised, and so on. Finally, the pulsed wave is 'fired' into the aerial's paraboloid reflector by a scalar feed, which is shaped to distribute the energy into the reflector. The pattern of the pencil beam formed by the reflector, with its diameter of 25 m, is identical for both polarisations. Waves returning to the receiver follow precisely the same path as for transmission, but in the reverse direction.

The mechanical vane was used because no available solid-state device was capable of switching the 500-kW pulses at a pulse repetition rate of 610 pulses/second. Switching has to be that fast, for the raindrops are continuously in motion relative to one another and interference between the reflections contributed from individual drops gives rise to rapid fading of the returned wave; the data samples for both polarisation have to be obtained in a short enough time for such fluctuations to have no effect.

The technique requires Z_{DR} to be measured precisely; the measured standard deviation of the random errors lies between 0.05 and 0.1 dB, depending on the mean value, with a corresponding fixed error (inherent to such a measuring system) of less than 0.1 dB. Corresponding errors for Z are 0.75 and 1.0 dB, respectively. This means that estimated errors in measured rainfall are less than 40 per cent, and only about 10 per cent in the measured rate at which a radio wave is attenuated along its path by the rain.

4

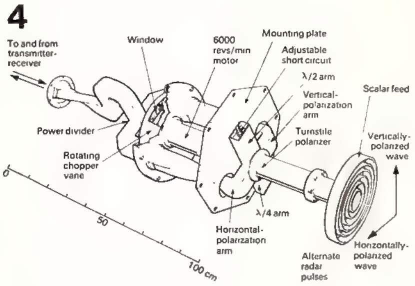


Figure 4. Dual polarisation switch and feed assembly. Windows in the rotating chopper vane pass the radar pulses from the transmitter alternately to the vertical-polarisation and horizontal polarisation arms. When the energy reaches the turnstile polariser, some of it passes into the quarter-wave arm and some into the half-wave arm. Energy reflected from the terminations of the arms recombines in such a way that the pulses fed to the aerial via the scalar feed are polarised alternately in the vertical and horizontal planes.

Satellite communications

The aim in building the radar was to examine the way that small zones in intense rain affected radio links, particularly links between ground stations and satellites, so that theoretical models could be produced for use in planning communications systems. The ability to observe rain over large areas and up to considerable altitudes gives radar an immediate advantage over rain gauges on the ground. Attempting to predict attenuation by rain along the communications path from reflectivity data obtained by conventional radar means making an assumption about the distribution of the raindrop sizes. Furthermore, such data are likely to be misinterpreted when hydrometeors other than rain, for example snow or hail, are present. Dual-polarisation radar overcomes these problems. Only rain within a few tens of metres from the direct path of communication contributes to attenuation, so relatively small but intense features in the structure of the rain may produce short but deep fades. Knowing the drop size distribution is particularly important, because it changes quite rapidly within the rain zone.

Verification

To test the technique, data from the radar was compared with those from a satellite-to-ground radio link operated at a frequency of 12 GHz (gigahertz) by the UK Independent Broadcasting Authority at a station five kilometres from the radar site. Figure 6 shows how Z and Z_{DR} varied during one set of measurements. The two ordinate scales show the slant range r along the communication path and the corresponding altitudes.

$A_c(r)$ is the summation of attenuation caused by rain along the path, progressively from the ground station. It is seen that the rate of increase in $A_c(r)$ is highest at slant ranges between two and four kilometres from the station, where the rain is most intense. In that region, both Z and Z_{DR} are high. At an altitude of three kilometres and a slant range of six kilometres there is a region of high Z and apparently high Z_{DR}. This is the altitude at which falling ice crystals or snow melt to become raindrops. The large, wet snowflakes are sometimes more easy to recognise from their differential reflectivity than from their absolute reflectivity. In this instance, rain below this altitude contributes 2 dB of attenuation, whereas the attenuation caused by wet snow has to be evaluated by other means becaude we are no longer dealing with drops of water. Tests have been done for light rain on only a few occasions the drop sizes are generally small; and in such conditions the technique is least accurate, but almost all values of radar-derived attenuation computed so far have been within 0.5 dB of direct measurements, the standard deviation being only 0.3 dB.

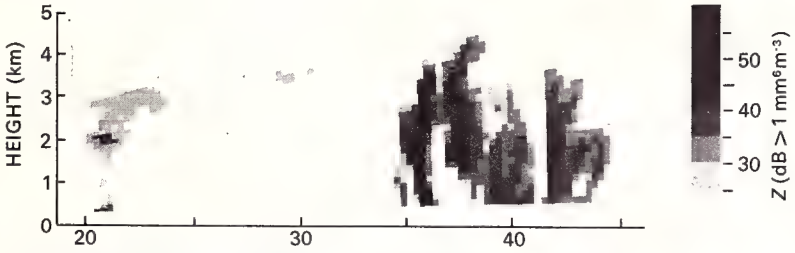
In the small, intense cells of rain which accompany thunderstorms and which cause the highest attenuation, drop sizes are usually larger and the accuracy may be expected to be greater. For rain examined, the estimation of the attenuation using the absolute reflectivity alone (all that is available from a conventional radar), and assuming a constant statistical distribution for the drop sizes, produced an error factor of about two.

In small regions of rain, the corresponding error factor in computing the rate of increase in $A_c(r)$ was four. Subject to wider-ranging tests, it is expected that the dual-polarisation technique will improve the modelling of attenuation by rain over a range of radio frequencies, and enable several studies to be made of how to keep the effects of rain on future communications systems to a minimum.

Other applications

The technique should be important to other work, too. Measurements have shown that the largest drops in intense rain have a diameter

5 (a) Single-polarization radar data



(b) Additional dual-polarization data

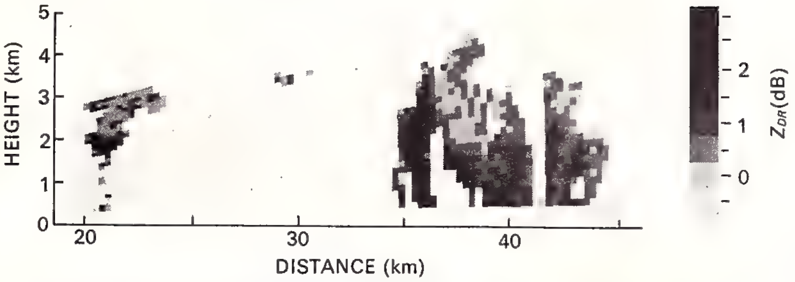
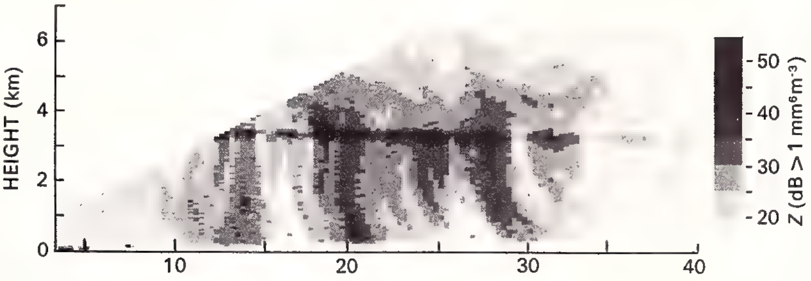


Figure 5. Here a pillar of supercooled water is seen so extend up through the melting layer (at an altitude of 1.9 km) to a height of 3.5 km. Such phenomena are a hazard to aircraft, causing ice to form.

6 (a) Single-polarization radar data



(b) Additional dual-polarization data

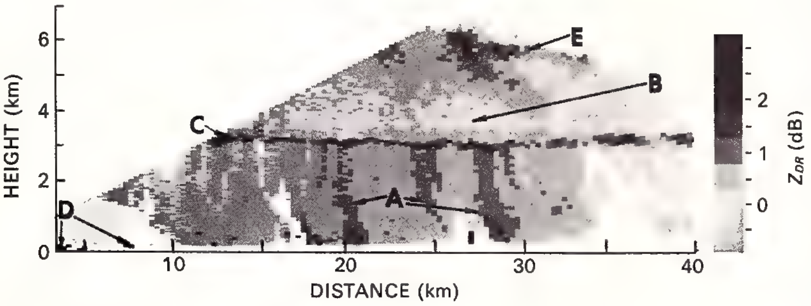


Figure 6. Vertical scan of the radar beam showing rain (A), ice clould (B), the melting layer (bright band), echoes from ground (D), and zones of high Z_{DR} (E) well above the melting layer.

of more than 0.8 cm. In the particular conditions investigated, if we assume an exponential distribution of drop sizes, one drop in the rate of 0.55 to 0.65 cm diameter would occur per 2.4 m^3 volume of rain, and one in the range of 0.65 to 0.75 cm would occur per 7.0 m^3. This sort of information is useful to scientists interested in the effect that raindrops have on high-speed aircraft and to others seeking to assess what heavy rain might do to crops.

Detecting regions of supercooled water is potentially valuable in aeronautics, for they can cause ice to accumulate rapidly and disastrously on aircraft. Figure 6 contains an example of high Z_{DR} values extending to the top of the region of high Z. This indicates a convective column of supercooled drops up to an altitude of 3.5 km, nearly twice the height of the melting layer. Without dual-polarisation measurements, it would not be clear whether such regions of high Z represented ice cloud or drops of water.

We are also thinking about how the technique could be used to avoid certain problems met with when using radars to forecast how rain is likely to travel in the following hour or two. Although it is not essential to know the drop size distribution in rain accurately if we want to estimate average rainfall over a large area, the dual-polarisation technique is likely to help us automatically distinguish rain from non-precipitating ice clouds (and from ground echoes, too, because they are characterised by the large variance of their Z_{DR}. The variance includes quite large negative values not found in echoes from other sources).

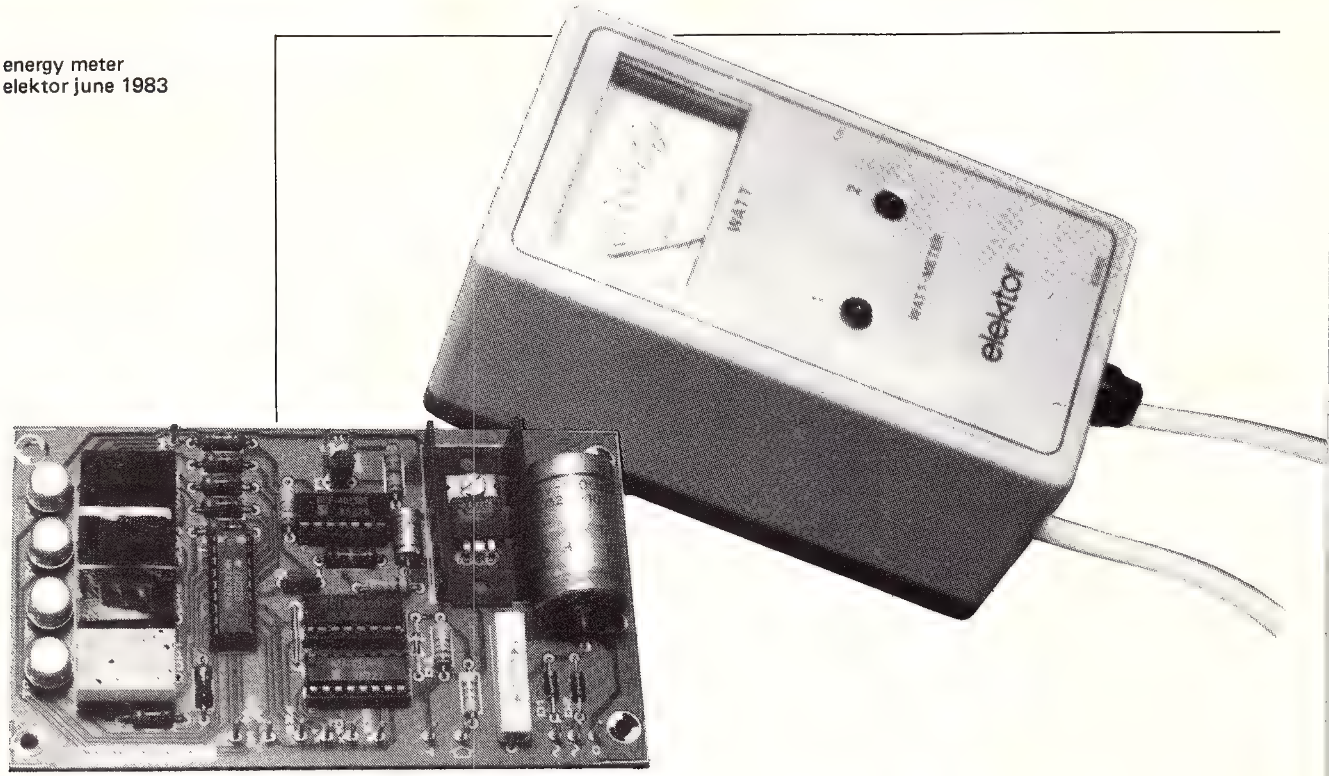
There is also a great deal in the technique to interest cloud physicists. Figure 6 shows vertical sections through rain, ice cloud, the melting layer (bright band) and echoes from ground. It also shows, well above the melting layer, zones of high Z_{DR} which probably contain horizontally-orientated plates of ice crystals; later, the crystals aggregate and tumble as they fall, giving near-zero Z_{DR}.

Basic studies of drop sizes in rain are being made on the ground with the aid of a drop-sizing device known as a Joss distrometer and a rain gauge, while measurements of drop sizes in the air are being made with a 2-D Knollenberg distrometer carried in a research aircraft of the UK Meteorological Office. Data collected directly in that way, when combined with data from the radar, are revealing how well we may except a simple model to behave when used to describe the statistical distribution of drop sizes in various kinds of rain.

Another promising application lies in providing reference data with which to compare the remote-sensing of clouds by satellites. Observations from the satellites may cover the whole of the Earth's atmosphere, but where they fall within the range of the radar, the radar data can be used to calibrate those from the satellite in terms of rainfall below the cloud and, perhaps, the type of hydrometeor within the cloud.

Martin Hall, Spectrum

(870 S)



energy meter

from watt to kilowatt-hour meter

Energy costs money and these costs are rising in line with the demand and shrinking resources. Nobody escapes these costs and it is therefore of interest to all but very wealthy consumers to know how much energy a certain appliance has consumed over a certain period of time. A (kilo)watt-hour meter will tell you accurately. This knowledge will also help in determining the cost-effectiveness of energy-saving measures. In this article we will tell you how the watt-meter featured in our May issue can be expanded to become an energy meter.

If you want to know how much energy an appliance has drawn from the mains supply over a given period, you have to multiply the power consumed by the appliance in watts with the time in seconds or hours. Unfortunately, the power consumed by many appliances is not constant; in the case of a refrigerator, for instance, the motor only runs when the thermostat tells it to and even then it does so with varying loads. The calculation is then no longer so simple: first the mean power consumed will have to be determined and that is a matter of averaging or integration. Multiplying the mean power so found with the time will give the amount of energy used.

The use of a measuring instrument like the energy meter described in this article will obviate the need for these calculations: fairly simple electronic circuits will average the power consumed and multiply this by the time. The block diagram in figure 1 shows the principle of operation. The input circuit is fed with the VCO output signal of

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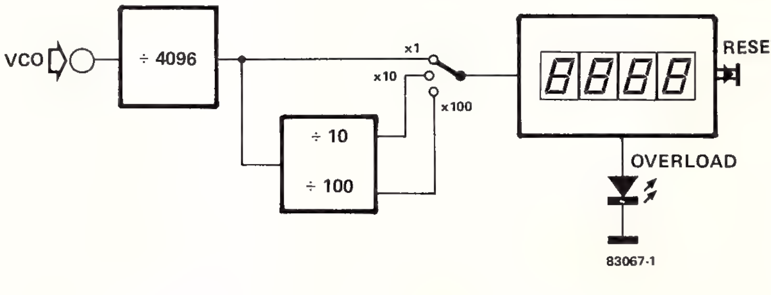

Figure 1. Block schematic diagram of the circuit necessary to expand the watt-meter published in our May issue into an energy meter. The extension consists of a digital counter which counts pulses produced by a VCO in the watt-meter. The number of pulses is directly proportional to the measured power and time.

the watt-meter. The frequency of the VCO signal is in direct proportion to the power measured by the watt-meter: the higher the power, the higher the frequency. To convert the watt-meter to an energy meter only the addition of a fairly simple digital counter is needed. The VCO frequency is first divided by 4096; dependent upon the desired meter-scale, it is then divided by 10 or 100 (this increases the measuring range by 10 and 100 respectively). The dividers are followed by the actual counter which gives a four-digit read-out. Finally, there is a reset switch for resetting the circuit to zero.

Assuming that the watt-meter is connected to a refrigerator, the moment the motor of this appliance starts to run, the VCO in the watt-meter will provide countpulses to the expansion circuit which are directly proportional to the power consumed by the fridge. If that power varies, the VCO frequency will change. When the fridge motor switches off, the VCO ceases to generate pulses and the last counter position is retained. When the fridge switches on again, the VCO fires and the counter resumes counting. After a while the counter will indicate exactly how many watt-hours of energy the fridge has used.

The counter has a maximum capacity; the overload indicator gives warning that the counter has gone through this maximum and started again: if there were no such indicator, the displayed count could be misleading.

As stated, the VCO frequency is first divided by 4096. In principle, this divider could be omitted by operating the VCO at a lower frequency. However, not only does the higher frequency lie in a more suitable range for the oscillator, but it also has the advantage that the switch-on periods of an appliance can be averaged out much more accurately. This is of particular importance in the case of appliances which, within the period of measuring, switch on and off quite frequently.

The VCO

A description of the operation of the VCO was not included in the article on the watt-meter in the May issue, and this follows now. The circuit diagram of the VCO is shown in figure 2. Although in fact it is not a voltage but a current controlled oscillator, its operation remains the same.

The VCO is designed round an operational transconductance amplifier (OTA), A6, and operational amplifier A4 which is connected as a comparator. Dependent upon the measured power, transistor T1 provides the OTA with drive current. The current from T1 also charges capacitor C1 in a time which is again dependent upon the measured power. The resulting voltage level across C1 is applied to the input of comparator A4 via the buffer stage contained in the OTA stage. It this voltage exceeds the upper threshold, the output of the comparator goes negative. At the same instant the input current (pin 3) of the OTA also becomes negative, which causes C1 to *discharge* at a speed which is dependent upon the drive current at pin 1. In this way the VCO provides a square-wave at its output of which the frequency is directly proportional to its drive current, that is, the measured power. The hysteresis of the comparator, and consequently the frequency of the VCO, can be adjusted by means of potentiometer P4. This is of importance during the calibration of the meter which is discussed later in this article.

Energy meter extension

The circuit shown in figure 3 enables the watt-meter to be converted to a kilowatt-hour or energy meter. As stated, the input of the circuit is connected to the output of the VCO in the watt-meter. The VCO signal is applied to the input of 1 : 4096 divider IC2 via voltage divider R2-R3. The divided square wave is again divided by 10 or 100 in IC3. Dependent on the required scale,

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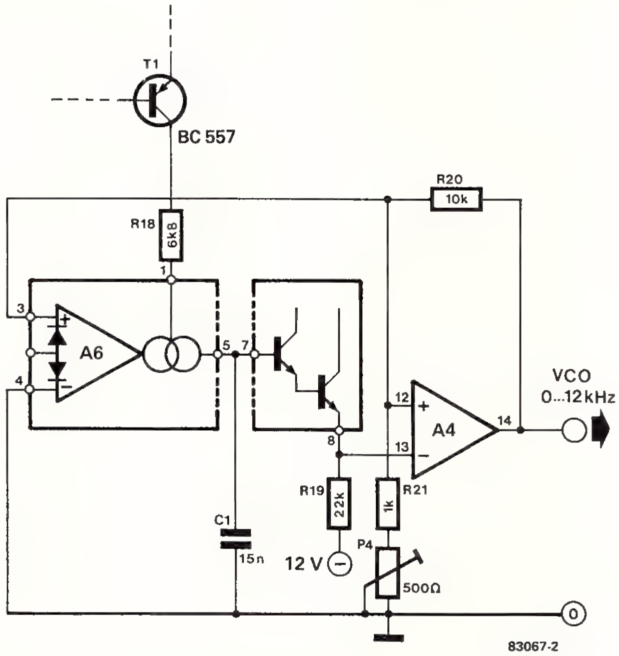

Figure 2. The VCO which is located on the printed circuit board of the watt-meter consists of an OTA (A6) and an op-amp (A4) which is connected as a comparator with hysteresis. Dependent on the power consumed, the OTA is fed with a certain drive current and arranges, in combination with the comparator, for the successive charging and discharging of capacitor C1. The output of the comparator therefore consists of a square wave of which the frequency is dependent upon the measured power.

switch S2a can apply the output of IC2 to counter IC5 either directly or via IC3. The integrated counter drives a four-digit 7-segment display. The decimal points of the display are determined by the position of S2b (the meter range switch).

The counter is reset by pressing push-button switch S1; at the same time the two dividers IC2 and IC3 are reset to the zero-position. To get an indication when the counter has reached its maximum capacity, use is made of its 'carry out' terminal (pin 14). At the moment the counter changes from 9999 to 0000, the logic bit at pin 14 changes from 1 to 0, which causes capacitor C3 to charge via resistor R5. When the resulting voltage at the clock-input (pin 3) of bi-stable IC4 reaches logic 1, its output Q also becomes 1 (+5 V). Transistor T1 is then fired and LED D4 lights, indicating that the counter has gone past its maximum at least once. It should be noted here that when the counter and dividers are reset, the bi-stable should also be reset to zero.

Although highly desirable, the reset facility is not fitted on electro-mechanical kilowatt-hour meters provided by Electricity Boards, for obvious reasons. On the meter described, the facility is not just useful, it is essential: at the onset of each measurement, the meter is reset so that noting down the reading at the start becomes unnecessary.

As far as meter ranges are concerned, switch S2 makes possible the selection of three. The scale factor is a somewhat more difficult problem, as this is dependent upon the divide factor and the shunt resistance in the watt-meter. This problem will be returned to later in this article.

The watt-meter and kWh extension can be fed from one 2 x 15 V, minimum 0.7 A, transformer. The voltage stabiliser, IC1, of the kWh section reduces the voltage rectified by diodes D1 and D3 to 5 V. The stabiliser is protected against overload by resistor R1. This resistor is replaced by a wire-bridge if the kWh extension is fed by a separate transformer of 2 x 8 V or 2 x 9 V (minimum 700 mA) transformer.

Construction and adjustment

Readers who took our advice of delaying the fitting of the watt-meter in a box, can now house it together with the kWh extension in one case, which, from a safety point of view, should be made from a material that is a good insulator.

If the kWh section gets its own case, the connection between it and the watt-meter needs special attention. As the zero potential of the watt-meter circuit is connected electrically with the mains supply during measurements, the cable between the two cases must be capable of carrying 220 V AC. If a plug and socket connection is desired, these *must not* be of the ordinary household variety. There are many good quality 220 V handling types available which can be used and in effect prevent the units being inadvertently connected to the mains supply. When a plug and socket connection is chosen, the extension must, of course, have its own power supply.

To revert to the scale factor of the meter and the way S2b should be connected to the decimal points of the display, see figure 3. When the watt-meter gives full-scale deflec-

Figure 3. With this circuit the watt-meter is converted to an energy meter. The pulses generated by the VCO are applied to the input. The meter range is increased by connecting a further divider (IC3) between the input and counter IC5 by means of range switch S2. LED D4 lights up when the counter has reached its maximum capacity. Switch S1 is included to reset the circuit to zero.

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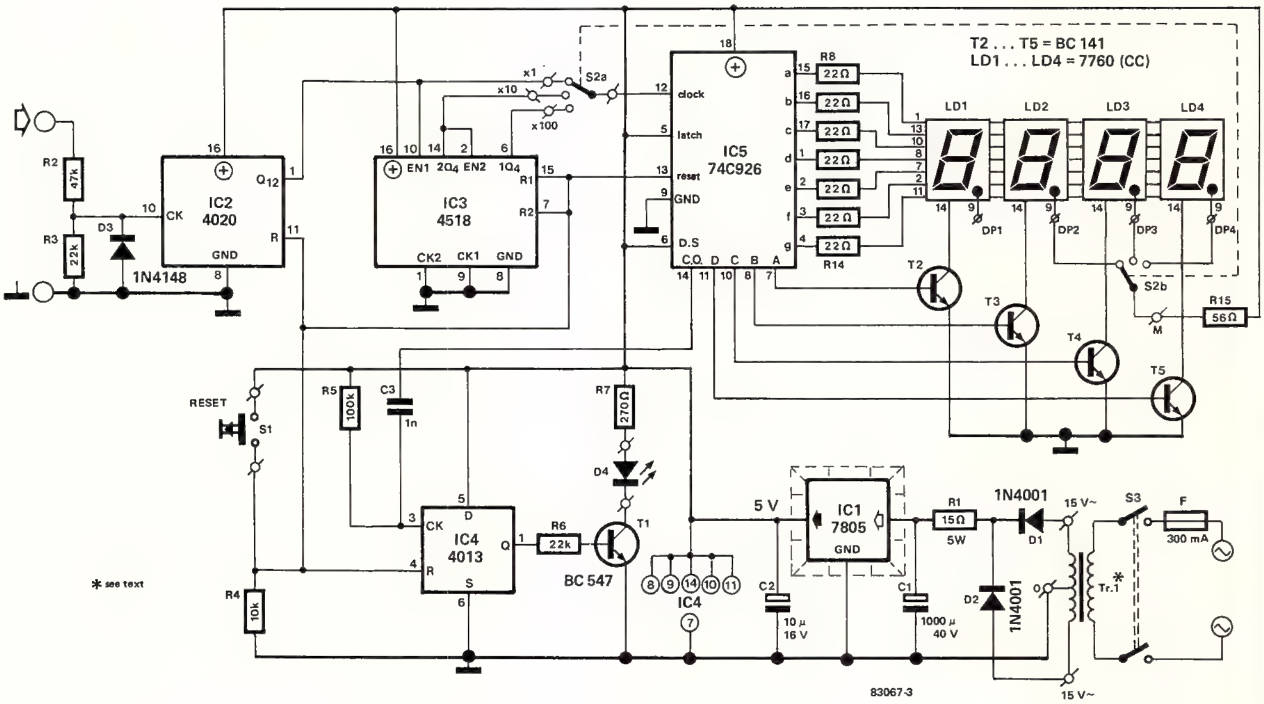

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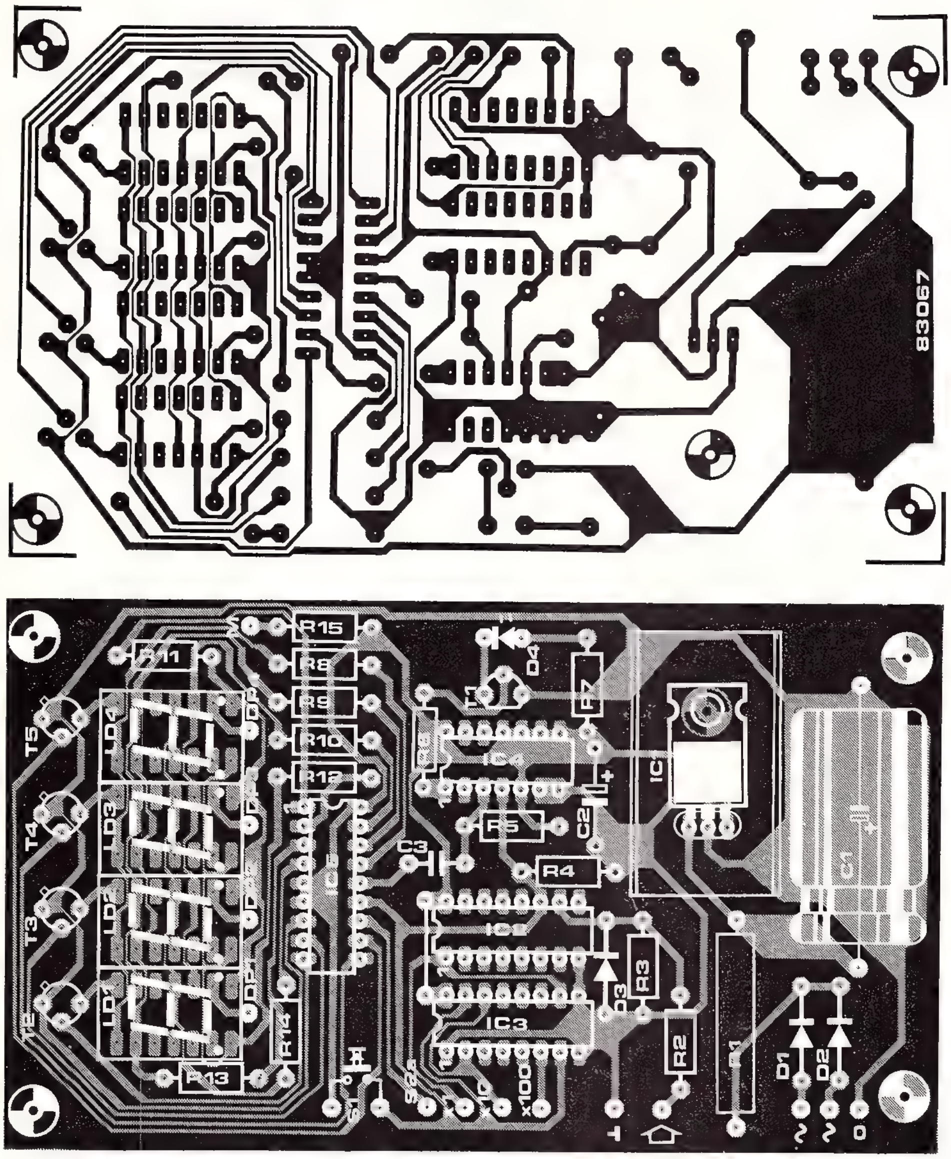


tion (FSD) at 100 watts and S2b is set to the lowest divide factor (as drawn), the display will read the maximum of 9999 after 1 hour. In round figures, this means that 100 watt-hours of energy has been used, so that for a read-out in Wh decimal point DP2 must light (99.99 Wh). When FSD is increased tenfold (S2 in position x10), the display will reach maximum after 10 hours, that is, when 1000 watt-hours of energy have been used. If Wh are to be read out, decimal point DP3 must light (999.9 Wh). It will be clear that with S2 in position x100, decimal point DP4 should light; FSD is then 10 kWh. The shunt resistance of the watt-meter has been calculated to give an FSD of 1000 watts: a larger FSD is for practical reasons not advisable as the required low value of the shunt resistance cannot be realised with sufficient accuracy. Even for an FSD of 1000 watts, the shunt resistance has a value of only 0.047 Ω. Resistors of that value are not available and can only be obtained by three 0.15 Ω resistors in parallel or by using resistance wire.

Finally, the calibration, which only concerns potentiometer P4 in the watt-meter. Assuming that that instrument has been calibrated correctly, connect the energy meter (that is, watt-meter + kWh extension) to a resistive load with a constant power consumption of, say 100 watts (NOT a thermostatically controlled appliance, but for instance a light bulb). Using an insulated screwdriver, set P4 such that the display after 0.1 hour (= 6 minutes) reads 10Wh. This procedure will have to be repeated several times for optimum results. Subsequently, repeat the adjustment for 1-hour periods when the read-out should be 100 Wh. Too low a reading is corrected by turning P4 clockwise (and too high a reading by turning it anti-clockwise).

A comparison with the Electricity Board kWh meter can, of course, also be made and this should give a very satisfactory calibration. The only point to remember in this method is that all other appliances connected to the mains supply must be switched off. ◼

Parts list

Resistors:
R1 = 15 Ω/3 W (see text)
R2 = 47 k
R3,R6 = 22 k
R4 = 10 k
R5 = 100 k
R7 = 270 Ω
R8 . . . R14 = 22 Ω
R15 = 56 Ω

Capacitors:
C1 = 1000 µ/40 V
C2 = 10 µ/16 V
C3 = 1 n

Semiconductors:
T1 = BC 547
T2 . . . T5 = BC 141
IC1 = 7805
IC2 = 4020
IC3 = 4518
IC4 = 4013
IC5 = 74C926
D1,D2 = 1N4001
D3 = 1N4148
D4 = LED (red)
LD1 . . . LD4 = 7760, 7-segment display (comm. cath.)

Miscellaneous:
S1 = push-button switch, 1 make
S2 = range switch, 2-pole, 3-way
Tr = mains transformer
a) 2x15 V, minimum 0,7 A
b) 2x15 V, minimum 0,7 A, with taps at 8 V or 9 V
} for watt-meter + kWh extension
(c) 2x9 V, minimum 0.7 A (kWh extension only) see text
heat sink for IC1
equipment case (watt-meter only) = BOC440 (watt-meter + kWh extension = BOC445) (available from West Hyde Developments Ltd)

switching channel for radio control

The proportional radio control systems which are available to modellers today are ideal where it concerns the control of speed and steering mechanisms. Many models, particularly model ships, have, however, a number of non-proportional on/off functions which modellers would like to control remotely: interior lighting, search lights, sirens, water cannon, and many more. The switch described in this articles offers the possibility to control five such functions over one channel without the need for servo-mechanisms and micro-switches.

pulse-width controlled switch

Proportional remote control systems operate by pulse-width detection. The position of the joystick results in a certain width of the transmitted pulses (between 1 and 2 milliseconds). The width of the pulse is translated in the receiver to a certain position of the servo control.

This type of proportional servo-control lends itself eminently to the continuously variable regulation of speed and steering, but the control of switching functions is somewhat more difficult, unless the use of a channel for every one or two such functions is acceptable. Fortunately, a small electronic circuit can improve the situation considerably; it consists of a one-gate oscillator, a decimal counter and a few buffers. Its principle is simple: when a pulse is received, a counter with five outputs operates; at the end of the pulse, one of the five outputs is active – which one depends on the width of the pulse.

The circuit diagram of the pulse-width controlled switch is shown in figure 1. The transmitted pulses have, as already stated, a width varying between 1 and 2 ms and are repeated at intervals of about 20 ms. As soon as such a pulse arrives at the input of the circuit, two things happen in quick succession. The positive edge of the pulse (that is, the very start) switches on counter IC2 via gate N4. Almost immediately afterwards, when the pulse reaches logic 1, the clock oscillator around N3 starts and IC2 commences counting. The clock oscillator provides a 5 kHz square-wave, which can be adjusted by means of P1. As long as the oscillator is working, therefore, IC2 is clocked every 0.2 ms.

IC2 is a decimal counter working as a shift register, which, in principle, can provide up to ten switched outputs; only five are used in the present circuit (because the pulse-width lies between 1 and 2 ms). Starting from zero, IC2 switches every 0.2 ms to the next successive output. After 1 ms, therefore, output 5 will be logic 1, after 1.2 ms output 6, and so on. It is seen, therefore that on the command of the pulses produced by clock oscillator N3, all outputs of IC2 become logic 1 in succession.

The sequential switching of the outputs

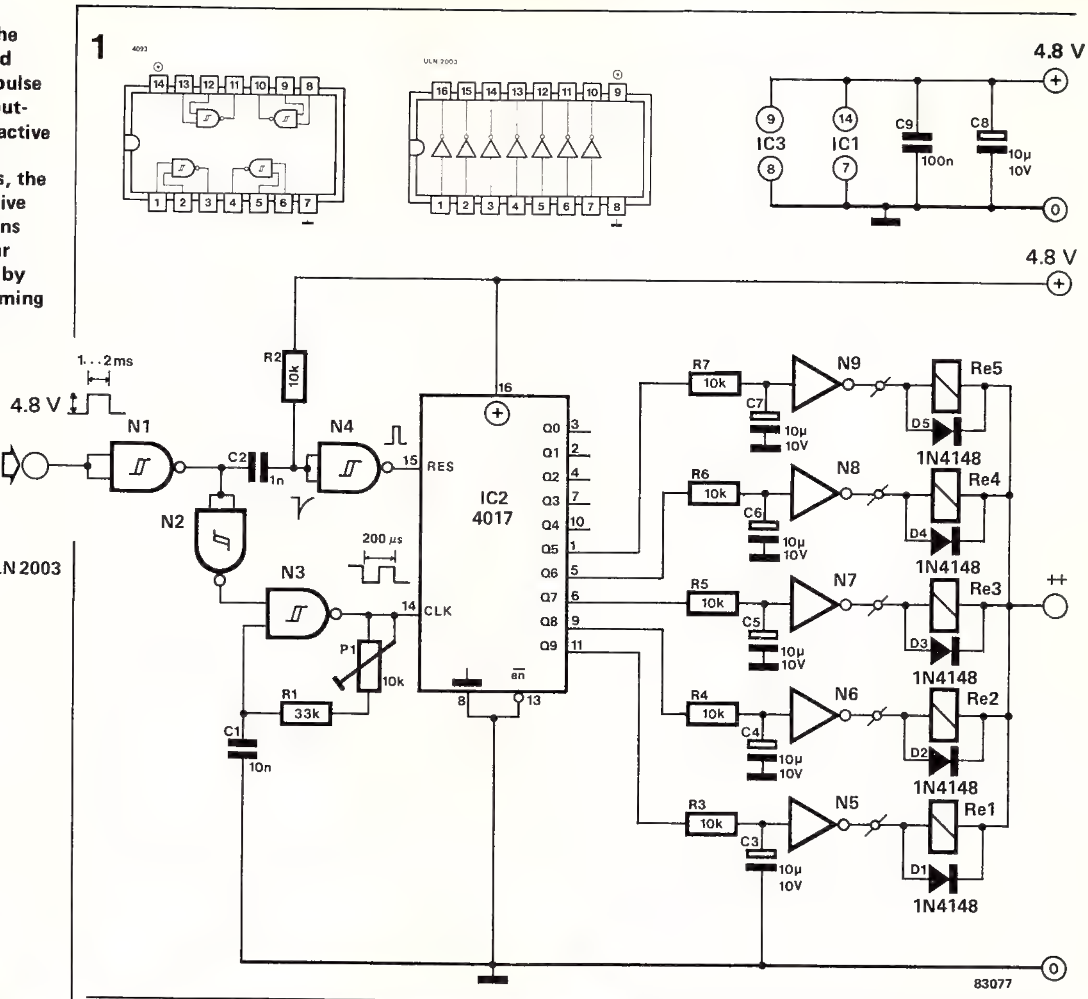


Figure 1. Circuit of the pulse-width controlled switch. As soon as a pulse arrives at the input, outputs 5 . . . 9 become active (logic 1) sequentially When the pulse ceases, the output which was active at that moment, retains logic 1. This particular output is determined by the width of the incoming pulse.

N1 . . . N4 = IC1 = 4093
N5 . . . N9 = 5/7 IC3 = ULN 2003

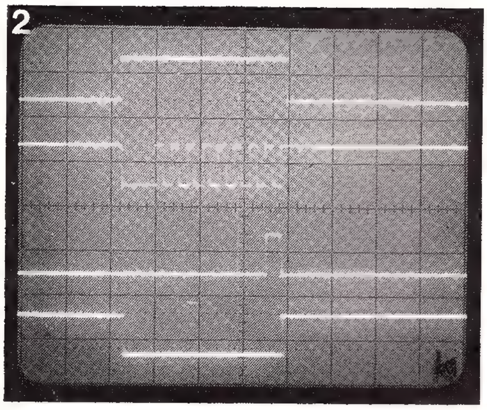


Figure 2. This picture shows that reality differs somewhat from theory: the input pulse (upper trace) fires the oscillator (second trace). The first period is a little longer than normal because C1 was fully discharged at that moment. This additional delay is compensated partly by the positive edge caused by the stopping of the oscillator and partly by the fact that the first positive edge occurs already after half the period. Trace 3 shows the signal at output 8 and trace 4 that at output 9. The latter was active (logic 1) and becomes 0 because IC2 resets at the rising edge of the input pulse; during the ninth positive edge of the oscillator, output 9 becomes 1 again and remains so until the next input pulse.

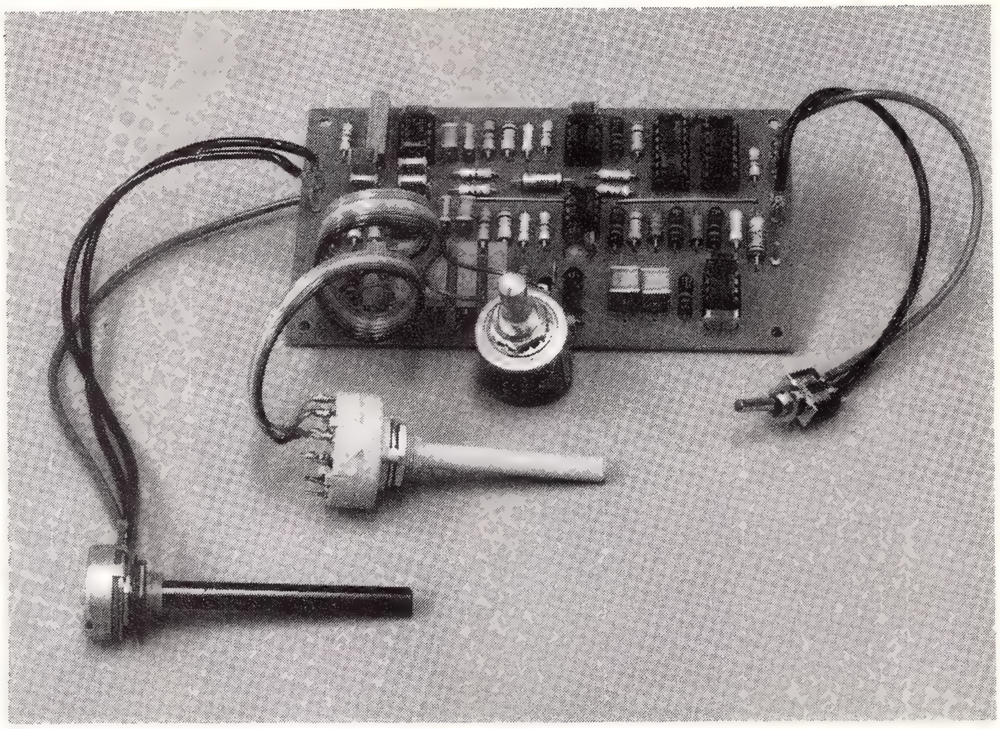
continues only for as long as the pulse lasts: when it ceases (and therefore the logic 1 disappears from the input), the counter output which was logic 1 at that moment, retains that state until the next pulse arrives after 20 ms. If this pulse, and the next, and the next, have the same width, the same counter output remains 'active' with only a short break every 20 ms when a new count procedure is initiated. However, by means of R3/C3 . . . R7/C7, the output signal is integrated over a few periods, so that the effects of the short break are obviated. At the open-collector output of gates N5 . . . N9 a logic 0 is therefore available at all times. The switching of small lamps (drawing less than 400 mA) can be effected by connecting them between one of the outputs of these gates and the positive supply line. Other switching functions are possible by the use of a relay: the relay coil, which should preferably be more than 100 Ω and on no account less than 20 Ω, is then connected between one of the outputs and the positive supply line.

Operation

The circuit works very well in practice, not in the least due to the impossibility of short interfering signals or the effects of missing pulses reaching the output. Also, the current consumption of only a few mA is hardly a drain on the battery. Connecting the circuit to the receiver should pose no problems as it is connected in exactly the same way as a normal servo.

Adjusting the circuit is also a straightforward affair. Preset potentiometer P1 is adjusted such that all channels switch correctly when the joystick is moved from one extreme to the other. It would be useful to draw some lines beside the joystick to mark the position where the switch-over from one channel to the next occurs. During operation all that has to be done then is to set the joystick between two of the lines to ensure correct operation.

A final remark: output gates N5 . . . N9 must not switch more than 400 mA and preferably considerably less; this prevents unnecessary problems and premature repairs. It is, however, possible to utilize the two unused buffers of IC3 to either treble the permitted output current of one of the outputs or double that of two of the outputs. All that is required to do so is to connect the appropriate output(s) to the relevant buffer input. ◼



RTTY decoder

Interest in Radio Teletype (RTTY) traffic has grown appreciably over the past few years. One of the reasons for this is that micro-computers, such as the Elektor Junior Computer, which find their way into more and more homes, lend themselves readily to this absorbing hobby. Such a computer can become an effective RTTY Decoder by the addition of a small electronic circuit and a suitable program.

teletype reception by computer

Our last issue contained articles on the decoding of morse signals by means of the Junior Computer and the Elektor Z80A card. In this issue it is the turn of teletype enthusiasts.

Owners of an expanded Junior Computer can save themselves the purchase of a costly teleprinter and RTTY converter. A simple interface and an EPROM with the right program will translate the teletype gibberish on short waves into a clear text on the screen.

The principle of transmission and decoding in teletype is not much different from that in morse. Digital coded information is transmitted by interrupting a radio carrier wave: this is called CW (keyed Continuous Waves). In morse transmissions, the interruptions are in accordance with the by today's standards somewhat cumbersome morse code; in teletype, with the logically constructed 5-unit CCITT Code No. 2, better known as the Baudot code. A more detailed treatment of this subject can be found elsewhere in this issue.

Apart from the codes, there is another fundamental difference between morse and teletype operation. In morse, only one carrier is transmitted which is interrupted in the rhythm of the dots and dashes of the morse code. In teletype operation two carriers are used, of which one is used for the transmission of the logic 1s and the other for the 0s. It is as if two transmitters are operating side by side, but each working on a different frequency. When the transmitted bit is 1, one of the transmitters is switched on, while the other is off; when the transmitted bit is 0, the first transmitter is off and the second is on. In reality only one transmitter is used of which the output frequency is shifted, according to whether a 1 or a 0 is transmitted. This method of operation is therefore called Frequency Shift Keying (FSK).

In teletype, logic 1 is called 'mark' and logic 0, 'space'. The transmission containing all the bits 1 is called the 'mark signal' and that containing only 0's, the 'space signal'. The mark and space signals are very close to one another: the frequency separation is called the 'shift'.

The output of the receiver therefore contains two different audio frequencies: one represents logic 1 (mark), the other logic 0 (space). When both are present simultaneously, there is a fault in the transmission.

The RTTY interface

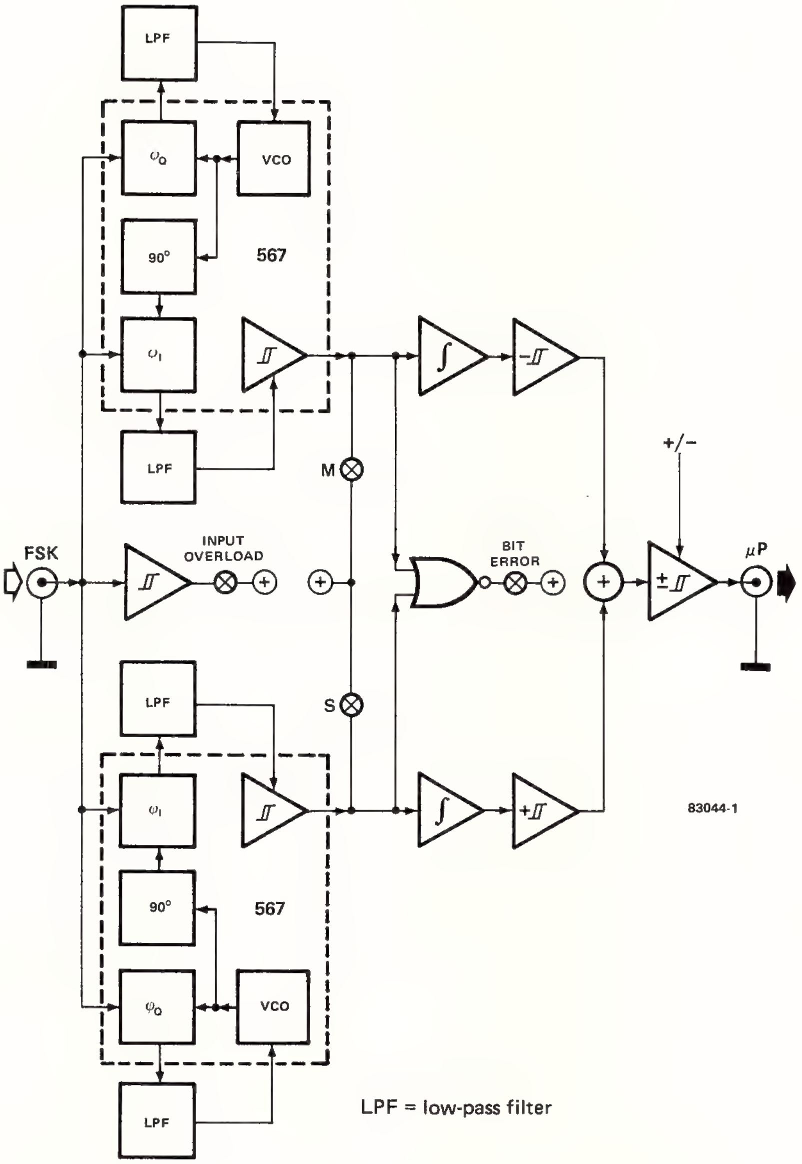
The signals emanating from the short-wave receiver are not suitable for driving the computer as this, as a norm, requires square-wave inputs. To modify the receiver output signals to the required shape, an interface is needed. This interface must be capable of differentiating between the two received frequencies and of transforming them into a digital signal. For this purpose use is made of a tone decoder followed by an integrator and Schmitt trigger. Two such set-ups are required in the RTTY interface because it has to cope with two different audio signals. With reference to figure 2, the level of the incoming audio signals is set as required by means of potentiometer P7 at the input of the circuit. Then follows a level indicator stage consisting of transistor T1 and a red LED, D1. The input signal is fed to two decoders, IC1 and IC2. Whereas tone decoder IC1 is aligned to one audio frequency, by means of potentiometer P8, decoder IC2 can be aligned to six different frequencies. This enables it to be switched to teletype transmissions with differing frequency shifts. Tone decoder IC1 is aligned to a nominal frequency of 1275 Hz. The frequency of decoder IC2 is then 1275 Hz ± the shift frequency. Table 1 gives the shift- and audio-frequencies normally encountered in RTTY traffic.

Table 1. Most frequently used audio and shift frequencies in RTTY traffic.

signal	set with:	frequency (audio) Hz	shift-frequency (Hz)
mark	P8	1275	0
space 1	P1	var.	var.
space 2	P2	1445	170
space 3	P3	1575	300
space 4	P4	1700	425
space 5	P5	2125	850
space 6	P6	2275	1000

The output circuit of the tone decoders contains three indicator LEDs: D2 (green) for the mark signal (IC1), D3 (red) for the space signal (IC2) and D4 (yellow) for the situation when a mark and space occur simultaneously. Because the frequency is shifted between mark and space, the overlap between the two signals during good reception is very small and D4 therefore lights rarely if at all. Bright lighting of D4 indicates a faulty adjustment or bad reception.

1



LPF = low-pass filter

Figure 1. Block diagram of the RTTY interface. The interface consists of two tone decoders with follow-on integrators and triggers for noise and interference suppression. Its output contains an adder circuit which will deliver a usable signal even when one of the two audio signals (mark or space) is missing. The NOR connection of the tone decoder signals ensures an indication of transmission failure. With correct settings, the LED indicators for mark and space light alternately at maximum brightness, whereas the error LED lights only dimly.

2

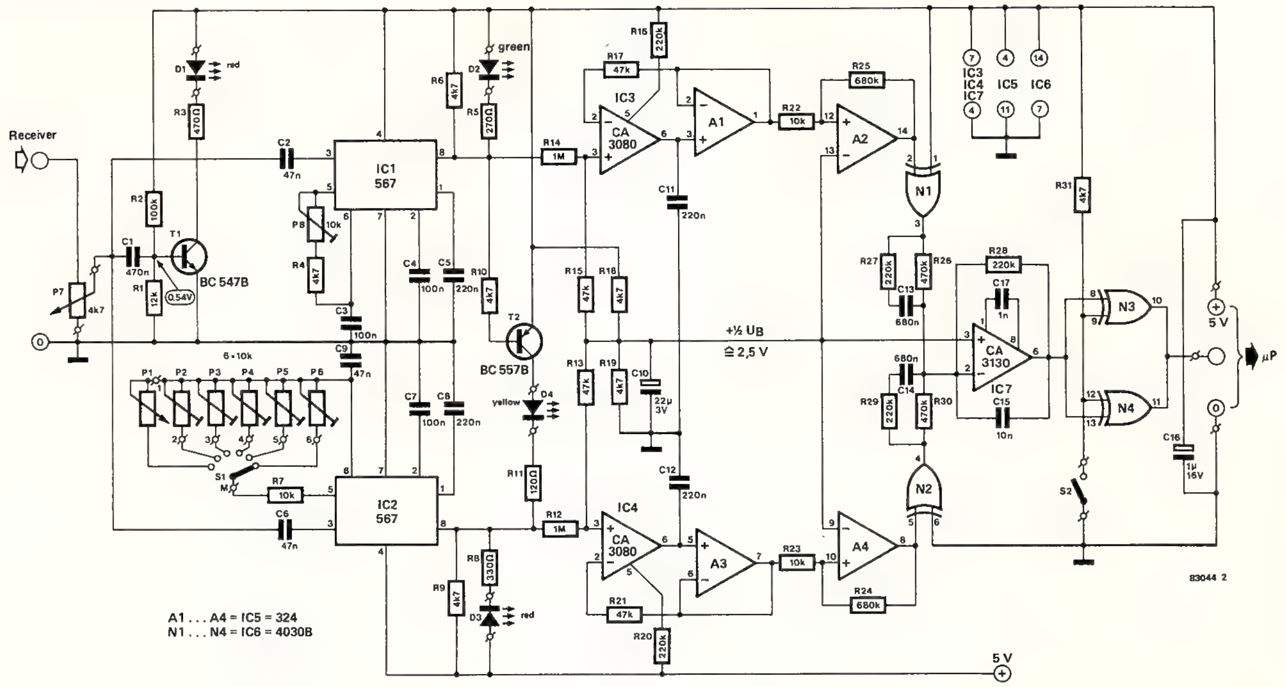


Figure 2. The interface circuit for teletype reception via the Junior Computer. It contains two tone decoders because in teletype operation two audio frequencies are keyed.

Both tone decoders are followed by OTA integrators IC3 and IC4, buffers A1 and A3, and triggers A2 and A4. The high-impedance buffers prevent the overloading of capacitors C11 and C12. The integrator and trigger section is identical to that of the morse interface described in our May issue.

Gate N1 is connected as an inverter; N2 does not invert because pin 6 has a 0 input. This is important in respect of operational amplifier IC7. This stage makes use of the fact that when one of the two signals, mark or space, is missing, the required teletype information in still fully available in the other signal. The space signal is out of phase with the mark signal but otherwise identical to it. If mark is logic 1, space is logic 0. Because N1 inverts the mark signal, whereas N2 passes the space signal unchanged, the output of the two gates contains two in-phase signals.

IC7 combines these signals in its inverting input circuit. If one of the signals is missing because of interference, the other will still be sufficient to drive the op-amp. Capacitor C15 in the negative feedback loop of IC7 ensures further integration of the audio signal by suppressing any residual unwanted signals. Gates N3 and N4 improve the slope of the square-wave output of IC7 so that a TTL compatible signal is available at the output of the interface. These gates also enable reversal of the polarity of the output signal. When S2 is open, both gates function as inverters, while when S2 is closed, they operate as non-inverting buffer stages. The setting of S2 is dependent on the teletype signal being received.

Presetting and adjustment

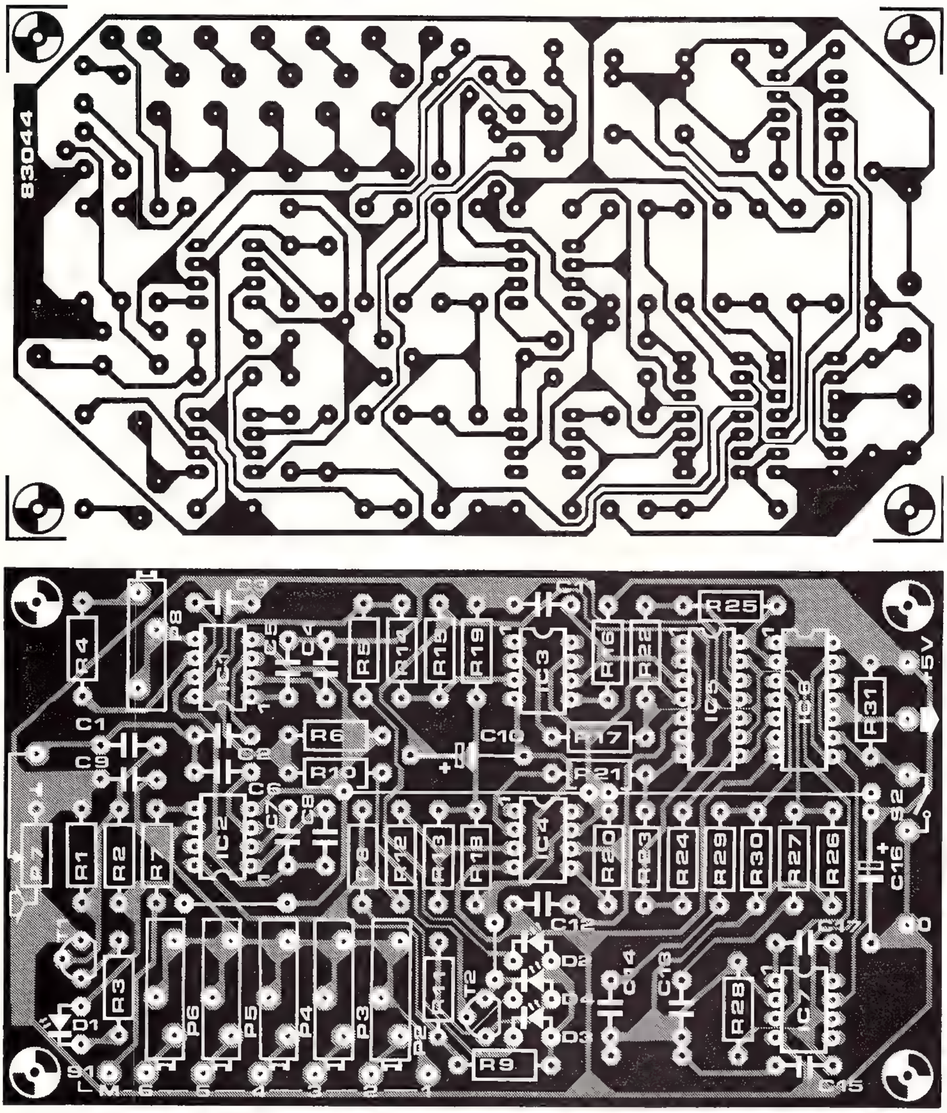
Once the RTTY decoder has been constructed on the printed circuit board shown in figure 3, it can be preset and adjusted by means of an audio generator and frequency meter. Both these instruments should be connected to the input (P7) of the interface. Set P7 to its mid-position, tune the generator to 1275 Hz (as indicated by the frequency meter) and adjust the generator output voltage until D1 just lights. It should now be possible to find a small range of travel of potentiometer P8 at which D2 lights. The correct position of P8 is in the centre of that range. It is also possible to reduce the generator output further and further while searching for a position of P8 where D2 lights. The position so found is the correct one.

Next, the adjustment of tone decoder IC2. Adjust potentiometers P2 . . . P6 in the same way as described for P8 above, but with the generator tuned to frequencies in accordance with table 1 (space frequency = 1275 Hz ± shift frequency).

Adjusting and presetting without using an audio generator and frequency meter is fairly difficult. When attempting to do so, it is best to set P7 to its mid-position and determine the shift-frequency of each transmission experimentally by adjusting potentiometer P1 with switch S1 set to position 1.

Once the above operations have been carried out, the interface can be connected to the audio output of a short-wave receiver. Search for a teletype transmission and adjust P7 so that LED D1 just lights. Then tune the receiver so that D2 lights as brightly as possible in rhythm with the incoming signal. Then select the correct frequency shift with switch S1. If the shift is not known, try all positions of S1 until one is found where D3 lights as brightly, and D4 as dimly, as possible. If such a position cannot be found, the shift is non-standard. In that case, set S1 to position 1 and adjust P1 to the shift of the incoming signal. When

3



Parts list

Resistors:
R1 = 12 k
R2 = 100 k
R3 = 470 Ω
R4,R5,R9,R10,R18,
R19,R31 = 4k7
R5 = 270 Ω
R7,R22,R23 = 10 k
R8 = 330 Ω
R11 = 120 Ω
R12,R14 = 1 M
R13,R15,R17,R21 = 47 k
R16, R20,
R27 . . . R29 = 220 k
R24,R25 = 680 k
R26,R30 = 470 k
P1 = 10 k 10-turn potentiometer
P2 . . . P6,P8 = 10 k 10-turn preset potentiometer
P7 = 4k7 (5 k) potentiometer

Capacitors:
C1 = 470 n
C2,C6,C9 = 47 n
C3,C4,C7 = 100 n
C5,C8,C11,C12 = 220 n
C10 = 22 μ/3 V
C13,C14 = 680 n
C15 = 10 n
C16 = 1 μ/6 V
C17 = 1 n

Semiconductors:
D1,D3 = LED red
D2 = LED green
D4 = LED yellow
T1 = BC 547B
T2 = BC 557B
IC1,IC2 = LM 567
IC3,IC4 = CA 3080
IC5 = LM 324
IC6 = 4030B
IC7 = CA 3130

Miscellaneous:
S1 = rotary switch, 1 pole, 6 way
S2 = single-pole switch toggle

Figure 3. The RTTY interface is constructed on this printed circuit board. The preset potentiometers are used for the setting of the various audio frequencies.

4

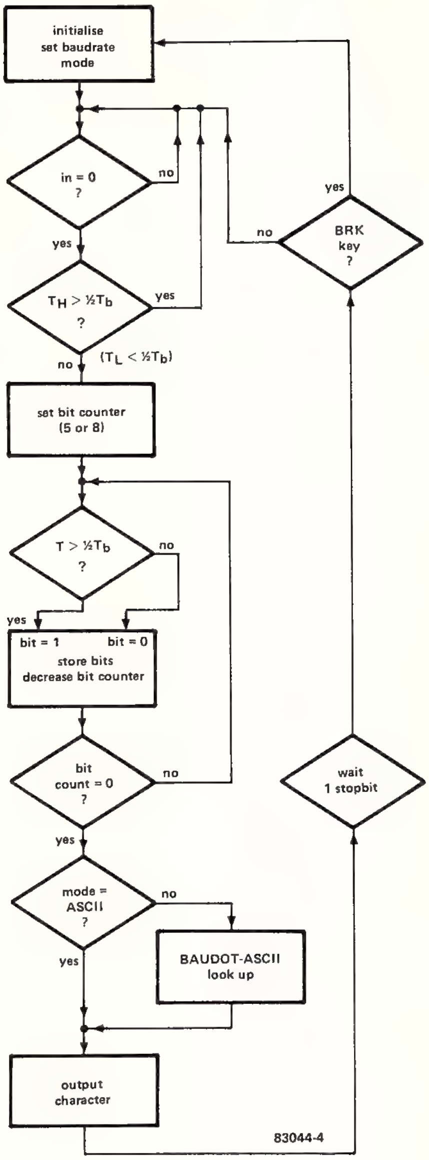


Figure 4. Simplified flow chart of the RTTY program. The 'heart' of the program is the bit counter. In contrast to an UAR/T which only scans the (calculated) centre of a pulse (unit of teletype signal), the counter determines whether the input signal during the pulse is longer than half the pulse duration for logic 1. If that is the case, it is taken to be 1, otherwise as 0. This system gives an appreciably lower susceptibility to interference, and therefore error rate, than is the case with UAR/T's.

Table 2. Print-out after starting the RTTY-program

```
BAUDRATE:

0=45.45 BAUD
1=50
2=57
3=75
4=100
5=110
DO YOU LIKE TO CHANGE IT? <Y/N>Y
SELECT THE BAUDRATE: 1
ASCII RECEIVER? <Y/N>N
FILE BUFFER? <Y/N>Y
AUTO LETTER MODE? <Y/N>
LIST THE FILE BUFFER? <Y/N>
::
```

Table 3. Starting addresses for the copy procedures.

junior versions	starting address	copied from	to address
expanded	0E88	0800	4000
DOS	EE72	E800	4000

reception is satisfactory and the interface is working correctly, the LEDs will flicker in rhythm with the incoming signal.
All that remains is the presetting of the baud rate (at the computer) and the polarity of the incoming signal (set by S2). Both are a matter of trial and error as firm rules cannot be given.

The RTTY decoder program

The program of the RTTY decoder can be contained in an EPROM type 2716. This EPROM is then suitable for use with the expanded Junior Computer as well as the DOS Junior.
The RTTY interface is connected to pin PB7 of the Junior Computer. The RTTY program is so arranged that both 5-unit Baudot and 7-unit ASCII codes can be received. Moreover, the program allows up to six baud-rates.
The received data are stored in a file buffer. When the buffer is full, an error signal is given. The contents of the buffer can, of course, be read out.
A further useful feature is the Auto-Letter-Mode: when receiving Baudot code, the letter sign is often lost. This results in letters being erroneously translated as numerals. In the Auto-Letter-Mode, the decoder automatically switches back to the letter mode when a blank space is received.
Figure 4 shows the program structure in a flow chart.
When the program has been started with the address 4000, possible baud rates are displayed as shown in table 2. The computer will ask some questions which should be answered by Y (Yes) or N (No = Return).
The baud-rate setting is effected by the keying in of a number between 0 and 5.
On reception of an ASCII transmission, the question 'ASCII Receiver?' must be answered by Y, because if the answer N is given, the decoder will be set to Baudot code.
After questions as to file buffer, Auto-Letter-Mode, and file buffer print out have been answered, the computer is ready to receive a serial signal across PB7; this is indicated by the display ': :'.
If the first question 'Do you like to change it?' is answered by N, the start procedure will be shortened. The decoder will then proceed in the Baudot mode with a baud rate of 50, indicated by the disappearance of the symbol ': :' from the screen.
If you want to find out the mode of operation after the program has started, simply press the Break key on the ASCII keyboard. Reset or Change of Mode of Operation is effected with the NMI key.

Operating instructions for the RTTY program

The program requires a storage capacity from 4000 up to 7FFF (RAM). A (dynamic) 16K RAM card on the Junior bus will be suitable.
The starting address is 4000.
As the DOS Junior has a storage capacity which differs from that of the expanded Junior, the program for it has been put

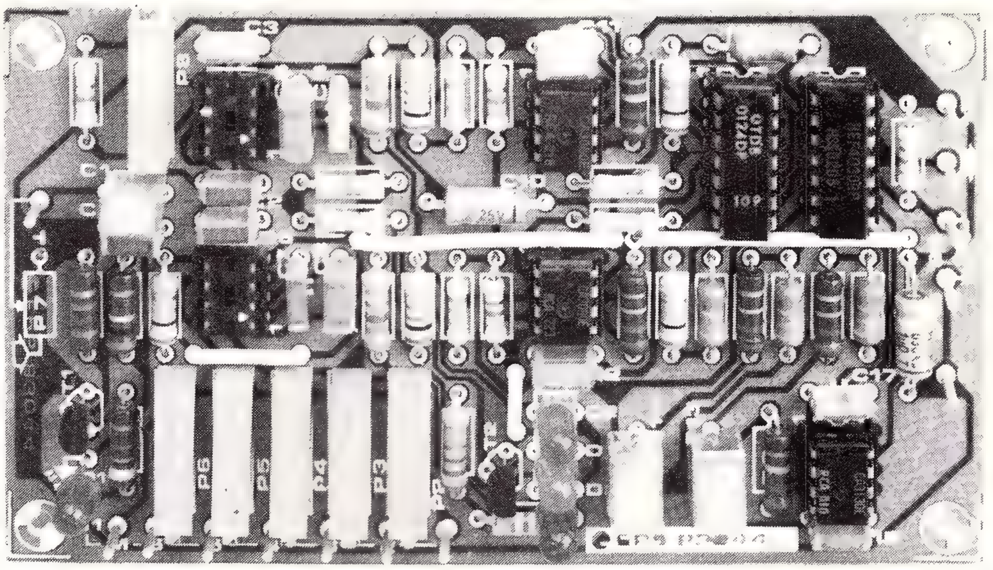


Table 4. Amendments for the DOS junior.

Address	Data
4038	A3
4039	FE

Table 5. Amendments for the expanded junior.

Address	Data
40C2. . .	EA, EA, EA
4038	34
4039	13
4041	1A
4057	AE
4058	12
44DA	1A
44DB	1A
44E4	1A
44E7	1A
44EC	1A
44F1	1A
44F6	1A
4581	1A
4589	1A
459B	18
45BE	18
45C8. . .	EA, EA, EA
45D1	1A
45CF	1A
45E0	18
4606	18
460D	18
4640	18
4646	18

Table 6. The hexdump of the RTTY decoding program.

```
      0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
800  4C BD 42 42 01 80 80 00 00 00 00 00 00 00 05 00
810  48 FF 7F 01 00 00 00 00 00 3F 35 00 0B F0 55 20
820  4E 88 44 15 34 10 27 83 23 4C 3C 40 8D 63 23 48
830  C9 00 F0 06 20 F8 44 20 43 23 68 60 AD 06 40 2D
840  80 FA F0 F8 A2 FF 9A 20 EB 41 4C 19 44 AD 14 40
850  48 A9 00 8D 14 40 20 1B FE 20 2C 40 AA 68 8D 14
860  40 8A 60 68 85 F8 68 85 F9 AD 14 40 48 A9 00 8D
870  14 40 E6 F8 D0 02 E6 F9 A0 00 B1 F8 C9 00 F0 06
880  20 2C 40 4C 72 40 68 8D 14 40 A5 F9 48 A5 F8 48
890  60 20 63 40 0D 0A 42 41 55 44 4F 54 20 00 60 20
8A0  63 40 0D 0A 41 53 43 49 49 20 00 60 20 63 40 52
8B0  45 43 45 49 56 45 52 0D 0A 00 60 20 63 40 20 42
8C0  41 55 44 0D 0A 00 60 20 63 40 34 35 2E 34 35 00
8D0  60 20 63 40 35 30 00 60 20 63 40 35 37 00 60 20
8E0  63 40 37 35 00 60 20 63 40 31 30 30 00 60 20 63
8F0  40 31 31 30 00 60 20 63 40 4E 4F 20 00 60 20 63
900  40 0D 0A 52 45 43 45 49 56 45 44 20 43 48 41 52
910  41 43 54 45 52 53 20 41 52 45 0D 0A 53 54 4F 52
920  45 44 20 49 4E 20 42 55 46 46 45 52 0D 0A 00 60
930  20 63 40 41 55 54 4F 20 4C 45 54 54 45 52 20 4D
940  4F 44 45 00 60 20 63 40 0D 0A 00 60 AD 14 40 8D
950  16 40 A9 00 8D 14 40 AD 0F 40 AE 10 40 C5 FA D0
960  1D E4 FB D0 19 20 63 40 0D 0A 46 49 4C 45 20 45
970  4D 50 54 59 0D 0A 00 AD 16 40 8D 14 40 60 85 FA
980  86 FB 20 45 41 A9 00 8D 1B 40 A0 00 B1 FA C9 FF
990  F0 E5 48 20 2C 40 20 E4 41 38 A5 FA ED 11 40 A5
9A0  FB ED 12 40 68 90 16 20 63 40 0D 0A 46 49 4C 45
9B0  20 4F 56 45 52 46 4C 4F 57 0D 0A 00 60 C9 0D D0
9C0  C9 20 2C 40 EE 1B 40 AE 1B 40 EC 1C 40 90 09 20
9D0  4D 40 C9 45 F0 A1 D0 AD A9 0A D1 FA F0 AC 20 2C
9E0  40 4C 8A 41 E6 FA D0 02 E6 FB 60 20 45 41 20 45
9F0  41 AD 03 40 C9 42 D0 06 20 91 40 4C 01 42 20 9F
A00  40 20 AC 40 AD 04 40 D0 06 20 C7 40 4C 3A 42 C9
A10  01 D0 06 20 D1 40 4C 3A 42 C9 02 D0 06 20 D8 40
A20  4C 3A 42 C9 03 D0 06 20 DF 40 4C 3A 42 C9 04 D0
A30  06 20 E6 40 4C 3A 42 20 EE 40 20 BB 40 AD 14 40
A40  F0 0C 20 FE 40 AD 17 40 F0 0A 20 30 41 60 20 F6
A50  40 4C 42 42 20 F6 40 4C 4A 42 C9 1F F0 19 C9 1B
A60  F0 0F AE 13 40 F0 05 AA BD 7D 42 60 AA BD 9D 42
A70  60 A9 00 8D 13 40 60 8D 13 40 A9 00 60 00 45 0A
A80  41 20 53 49 55 0D 44 52 4A 4E 46 43 4B 54 5A 4C
A90  57 48 59 50 51 4F 42 47 00 4D 58 56 00 00 33 0A
AA0  2D 20 27 38 37 0D 24 34 07 2C 00 3A 28 35 2B 29
AB0  32 00 36 30 31 39 3F 00 00 4D 58 56 00 20 A0 44
AC0  A2 FF 9A A9 05 8D 0E 40 A9 42 8D 03 40 A2 01 8E
AD0  04 40 8E 13 40 CA 8E 14 40 8E 17 40 20 63 40 0D
AE0  0A 45 4C 45 4B 54 4F 52 20 52 54 54 59 20 44 45
AF0  43 4F 44 45 52 0D 0A 0A 42 41 55 44 52 41 54 45
B00  3A 0D 0A 0A 30 3D 34 35 2E 34 35 20 42 41 55 44
B10  0D 0A 31 3D 35 30 0D 0A 32 3D 35 37 0D 0A 33 3D
B20  37 35 0D 0A 34 3D 31 30 30 0D 0A 35 3D 31 31 30
B30  0D 0A 44 4F 20 59 4F 55 20 4C 49 4B 45 20 54 4F
B40  20 43 48 41 4E 47 45 20 49 54 3F 20 3C 59 2F 4E
B50  3E 00 20 4D 40 C9 59 D0 5A 20 63 40 0D 0A 53 45

B60  4C 45 43 54 20 54 48 45 20 42 41 55 44 52 41 54
B70  45 3A 20 00 20 4D 40 C9 30 90 DE C9 36 B0 DA 29
B80  0F 8D 04 40 20 63 40 0D 0A 41 53 43 49 49 20 52
B90  45 43 45 49 56 45 52 3F 20 3C 59 2F 4E 3E 00 20
BA0  4D 40 C9 59 D0 10 A9 07 8D 0E 40 A9 41 8D 03 40
BB0  4C C0 43 4C 74 44 A9 05 8D 0E 40 A9 42 8D 03 40
BC0  20 63 40 0D 0A 46 49 4C 45 20 42 55 46 46 45 52
BD0  3F 20 3C 59 2F 4E 3E 00 20 4D 40 C9 59 D0 06 8D
BE0  14 40 4C EA 43 29 00 8D 14 40 20 63 40 0D 0A 41
BF0  55 54 4F 20 4C 45 54 54 45 52 20 4D 4F 44 45 3F
C00  20 3C 59 2F 4E 3E 00 20 4D 40 C9 59 D0 06 8D 17
C10  40 4C 19 44 29 00 8D 17 40 20 63 40 0D 0A 4C 49
C20  53 54 20 54 48 45 20 46 49 4C 45 20 42 55 46 46
C30  45 52 3F 20 3C 59 2F 4E 3E 00 20 4D 40 C9 59 D0
C40  03 20 4C 41 20 63 40 0D 0A 3A 3A 0D 0A 00 4C 74
C50  44 A9 00 8D 18 40 20 75 45 AE 03 40 E0 42 D0 03
C60  20 5A 42 AE 18 40 EC 19 40 B0 09 EC 1A 40 90 11
C70  C9 20 D0 0D A9 0D 20 2C 40 A9 0A 20 2C 40 4C 51
C80  44 C9 0A F0 0C C9 0D D0 02 A9 20 20 2C 40 EE 18
C90  40 AE 17 40 F0 07 C9 20 D0 03 8D 13 40 4C 56 44
CA0  78 AD 0F 40 AE 10 40 85 FA 86 FB A0 FF 98 C8 91
CB0  FA 20 E4 41 AE 11 40 E4 FA D0 F4 AE 12 40 E4 FB
CC0  D0 ED 91 FA 8C 15 40 8C 14 40 AD 0F 40 AE 10 40
CD0  85 FA 86 FB A9 3C A2 40 8D 7C FA 8E 7D FA A9 BD
CE0  A2 42 8D 7A FA 8E 7B FA A9 07 8D 82 FA A9 3F 8D
CF0  83 FA A9 00 8D 81 FA 60 AC 15 40 D0 1E C9 00 F0
D00  1A AC 14 40 F0 15 A4 FA CC 11 40 D0 07 A4 FB CC
D10  12 40 F0 08 A0 00 91 FA 20 E4 41 60 A0 01 8C 15
D20  40 20 A7 41 20 63 40 0D 0A 42 55 46 46 45 52 20
D30  4F 55 54 50 55 54 3F 20 3C 59 2F 4E 3E 00 20 4D
D40  40 C9 59 D0 09 20 45 41 20 45 41 20 4C 41 20 63
D50  40 0D 0A 53 59 53 54 45 4D 20 52 45 53 45 54 3F
D60  20 3C 59 2F 4E 3E 00 20 4D 40 C9 59 F0 01 60 4C
D70  BD 42 4C 3C 40 8A 48 98 48 AE 0E 40 AD 06 40 2D
D80  80 FA F0 EE AD 05 40 2D 82 FA D0 F0 20 4A 46 20
D90  CC 45 B0 E8 20 4A 46 A9 40 2D 0D F8 F0 F9 20 FC
DA0  45 20 CC 45 6E 0D 40 CA D0 F4 38 A9 08 ED 0E 40
DB0  AA 4E 0D 40 CA D0 FA 20 1D 46 A9 40 2D 0D F8 F0
DC0  F9 68 A8 68 AA AD 0D 40 8D 63 23 60 AD 05 40 2D
DD0  82 FA F0 1D EE 0B 40 D0 03 EE 0C 40 A9 40 2D 0D
DE0  F8 F0 E9 38 AD 0B 40 ED 09 40 AD 0C 40 ED 0A 40
DF0  60 EE 09 40 D0 03 EE 0A 40 4C DC 45 AD 04 40 0A
E00  A8 B9 1D 40 8D 04 F8 C8 B9 1D 40 8D 05 F8 A9 00
E10  8D 09 40 8D 0B 40 8D 0A 40 8D 0C 40 60 AD 04 40
E20  0A A8 B9 1D 40 8D 07 40 C8 B9 1D 40 8D 08 40 4E
E30  08 40 6E 07 40 4E 08 40 6E 07 40 AD 07 40 8D 04
E40  F8 AD 08 40 8D 05 F8 4C 0E 46 AD 04 40 0A A8 B9
E50  1D 40 8D 07 40 C8 B9 1D 40 8D 08 40 4C 35 46 A2
E60  08 A0 00 B1 00 91 02 88 D0 F9 E6 01 E6 03 CA D0
E70  F0 60 A9 00 A2 E8 85 00 86 01 A9 00 A2 40 85 02
E80  86 03 20 5F EE 4C 00 FC A9 08 A2 00 85 00 86 01
E90  A9 00 A2 40 85 02 86 03 20 9E 0E 4C 1D 1C A2 08
EA0  A0 00 B1 00 91 02 88 D0 F9 E6 01 E6 03 CA D0 F0
EB0  60
```

into an EPROM which should be plugged into socket IC4 on the Junior expansion card.

As the DOS Junior has a storage capacity which differs from that of the expanded Junior, the program for it has been put into an EPROM which should be plugged into socket IC4 on the Junior expansion card.

In the expanded Junior the program is stored from 0800 to 0FFF; in the DOS Junior, between E800 and EFFF. Before the program can be started, it must be transferred from the EPROM to the RAM. The required transfer procedure are already contained in the EPROM. The addresses for the various transfer procedures are given in table 3.

After transfer of the program, some bytes have to be changed by hand as shown in detail in table 4 (DOS Junior) or table 5 (expanded Junior).

After these amendments, the program can be started: it is possible to copy it from the RAM onto an audio cassette or floppy-disc (DOS Junior) for simpler re-use at a later date.

Readers who want to program the EPROM themselves will find the Hexdump listing in table 6. ◼

electronic aerial switch

simple and loss-free

from an idea by
C. Abegg

Many radio- and TV-amateurs have often wished they had a simple means of switching from one aerial to another. The normal solution is to do this by means of plug and socket arrangements, because a loss-free switch for changing aerials is not as simple as it sounds. This article shows that aerial switching is possible without introducing losses into the signal paths.

1

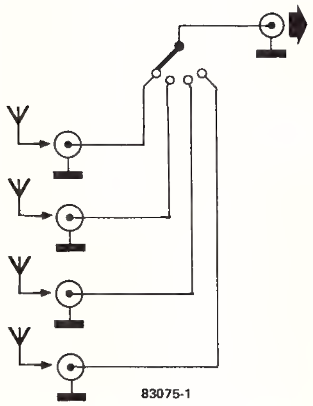


Figure 1. At medium- and short-wave frequencies, a normal switch can be used, but this would not be satisfactory at VHF and UHF.

2

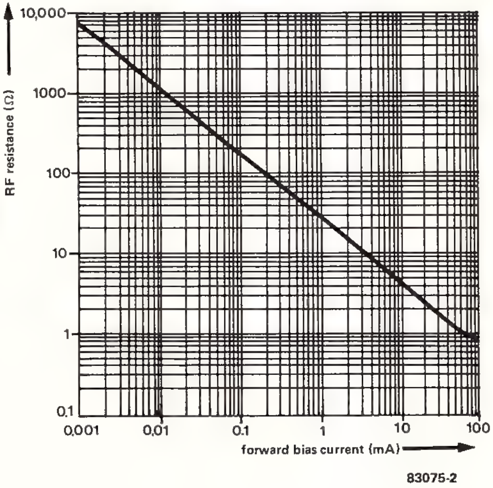


Figure 2. Characteristic of RF resistance vs forward bias current of a typical PIN diode.

The problem revolves around the losses caused by a mechanical switch. At relatively low frequencies (medium- and short-wave) such losses are not serious, but in the VHF and UHF bands they become a nasty problem. Even so, the most obvious and by far easiest way of selecting one of a number of aerials is by means of a mechanical switch as shown in figure 1.

There is, however, a means of obviating the disadvantages of a mechanical switch at high frequencies and that is by using PIN diodes which are ideal for this purpose.

PIN diodes

What are PIN diodes? Briefly, they are special switching diodes of which the most important property is a very low self-capacitance while at high frequencies they are virtually purely resistive. The resistance can be varied between 1 and 10,000 Ω by means of a direct current, the so-called forward bias current, as shown in figure 2. It is clear from this figure that the resistance of such a diode changes linearly over a wide range of values of current. This characteristic is ideal for a number of applications: by varying the forward bias current, the PIN diode can be used for the attenuation, equalisation or even amplitude modulation of high frequency signals; by switching the forward bias current, pulse modulation and phase-shifting of high frequency signals becomes feasible.

In the aerial switch described here, the PIN diodes are used in a simple way: as a high frequency switch. The forward bias current is set relatively high and, apart from this current, the only requirement is a switch. Figure 3 shows how this works: when the switch is closed, the diode conducts; when the switch is open, the diode is cut off.

Circuit description

Using PIN diodes, the switching between four aerials does not, therefore, present a real problem. All that is required is a current supply, a 4-position switch and four PIN diodes (see figure 4).

In practice, there is, of course, a little more to it, but not much, as can be seen from the complete circuit diagram in figure 5. The required forward bias current can be obtained from a normal +12 V supply (mains transformer, bridge rectifier and stabiliser IC, for instance). LEDs D5 . . . D8 are connected in series with the supply to give a ready indication which aerial has been switched in.

Depending upon the position of switch S1, the forward bias current first passes through one of the LEDs, subsequently through one of the chokes L1 . . . L4, then through the relevant PIN diode (D1 . . . D4) and finally to earth via choke L5 and resistor R1. This latter resistor determines the value of the current; at 680 Ω, as in figure 5, the current is 15 mA which is sufficient to ensure reliable switching of the diodes and satisfactory lighting of the LEDs.

Capacitors C1 . . . C4 and C9 are necessary to prevent DC appearing at the input and output of the circuit. Chokes L1 . . . L5 prevent the HF signal leaking to earth via the power supply line. Capacitors C5 . . . C8 decouple the power supply line for HF. Resistors R2 . . . R5 ensure that the anodes of the diodes not in use are earthed so that mixing of the various aerial signals is impossible.

Construction

In view of the small number of parts, the construction of the electronic aerial switch is a fairly simple matter. The only point which needs watching is that all wiring must be kept as short as possible to ensure satisfactory operation.

Chokes L1 . . . L5 can be wound on a ferrite bead: using enamelled copper wire of 0.3 mm diameter, two turns will suffice for UHF and five for VHF inputs. It is, of course, possible to buy them ready-made: 1 μH is required for UHF and about 5 μH for VHF.

The circuit has been designed for aerial input impedances of 50 . . . 75 ohms. Isolation between the various inputs is not less than 30 dB. Although the loss caused by switch S1 is minimal, the PIN diodes will deteriorate the noise factor of the receiver a little, but this will not be more than 1 dB. ◆

3

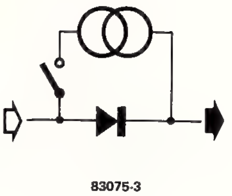


Figure 3. Principle of PIN diode switch.

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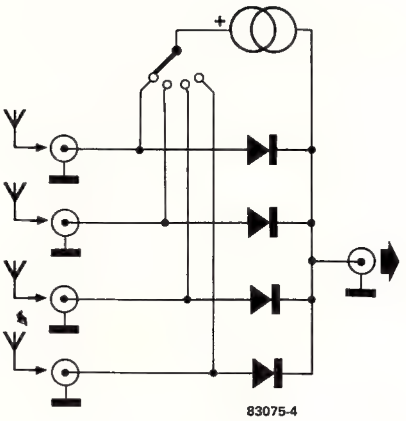

Figure 4. Aerial switch using PIN diodes. With the use of a 4-position switch and a power supply, one of the diodes can be switched on as required.

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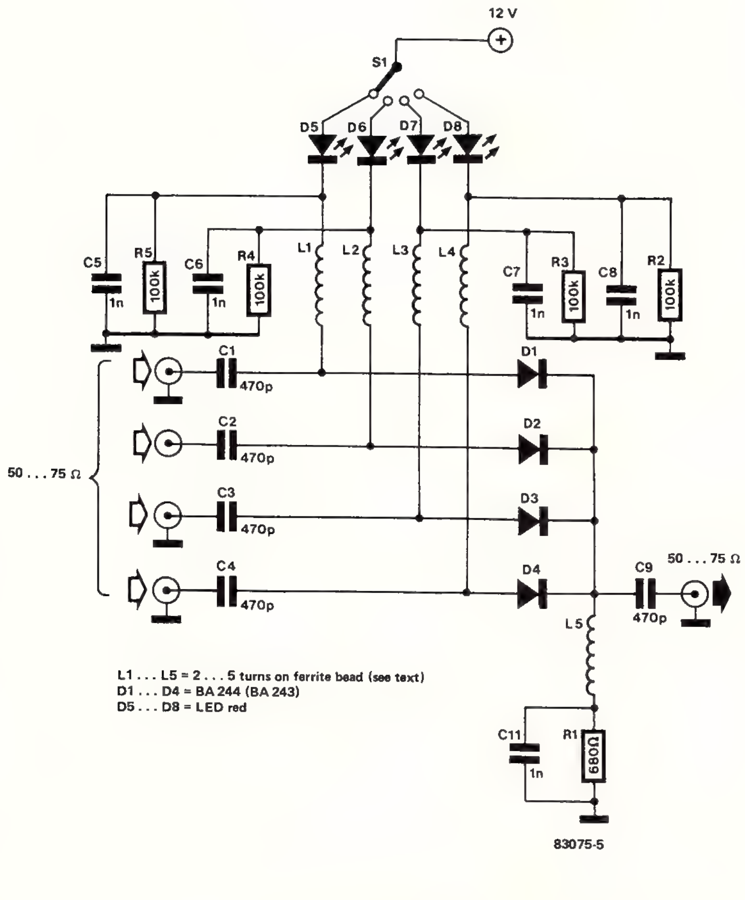

Figure 5. Complete circuit of the electronic aerial switch. LEDs D5 . . . D8 indicate which aerial has been switched in.

parts list

Resistors:
R1 = 680 Ω
R2 . . . R4 = 100 k

Capacitors:
C1 . . . C4,
C9 = 470 p ceramic
C5 . . . C8,
C11 = 1 n ceramic

Semiconductors:
D1 . . . D4 = PIN diode BA 244
D5 . . . D8 = LED, red, 5 mm

Chokes:
L1 . . . L5 = see text

Miscellaneous:
S1 = switch, 1-pole, 4-way
aerial input and output connectors

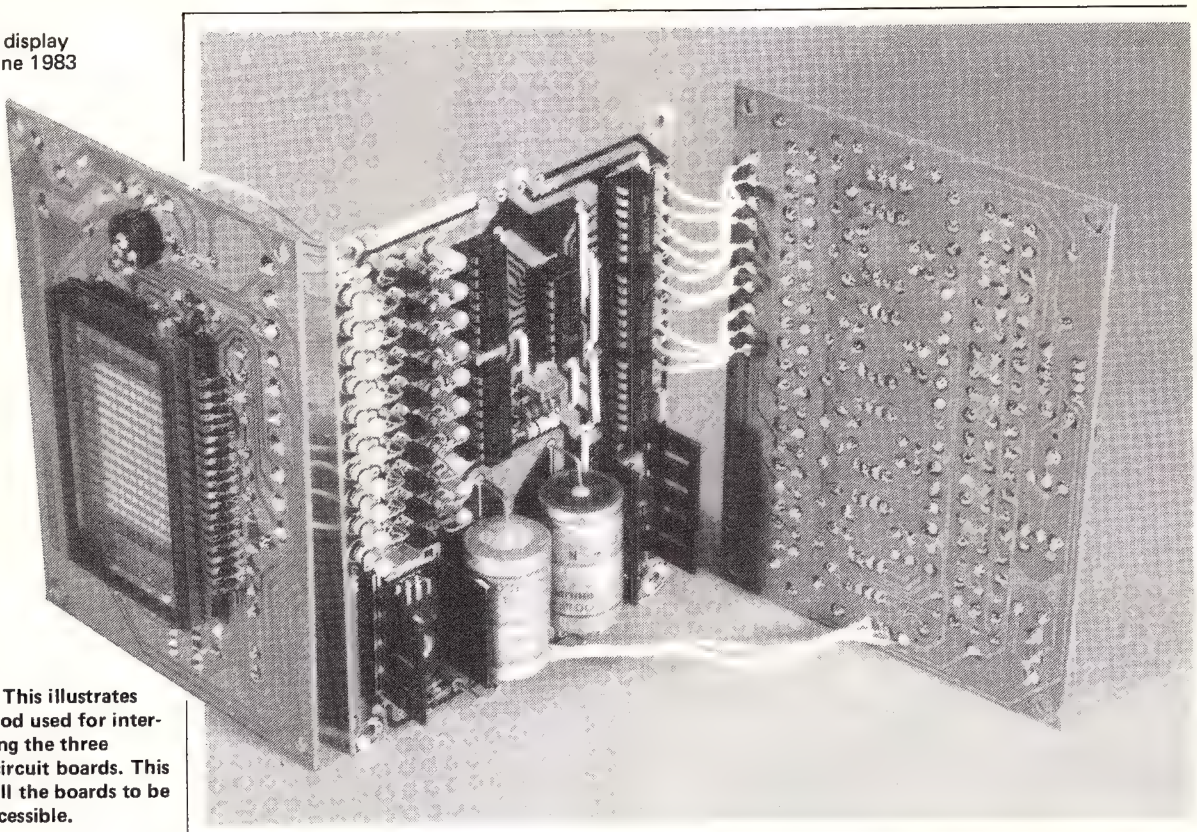

Photo 1. This illustrates the method used for interconnecting the three printed circuit boards. This enables all the boards to be freely accessible.

spectrum display

a graphical frequency spectrum display

We are all familiar with the usual line-o'-LEDs type of display that is so beloved by the manufacturers of contemporary Hi-Fi equipment. They are very pretty and, if interpreted correctly, do their job very well. However now that every 'solid state' meter is a series of different-coloured LEDs, either vertical or horizontal, the whole 'LED display' theme is becoming a bit old hat. But where do we go from here?

This article points the way! The display here consists of ten vertical columns providing an indication of not just the power output of the Hi-Fi system but the peak levels of ten frequencies throughout the audio spectrum. The display does not consist of row upon row of LEDs but one special fluorescent display matrix. This makes construction far simpler and provides a very professional appearance.

10 frequencies:
32-63-125-25-500-1 k-2 k-4 k-8 k-16 kHz
Amplitude read-out in
14 discrete steps of 1.4 dB
Input sensitivity:
90 mV . . . 1.8 V
Input impedance:
47 k

A spectrum display is really a sort of super VU meter with the advantage that peak values for a number of frequencies can be seen in a graphical form. Apart from being aesthetically appealing it can be very useful. A problem with magnetic recording tape is that it saturates more readily at higher frequencies than at lower frequencies. A spectrum display used for a recording meter would thus give a very good indication of exactly where in the frequency spectrum the peaks are occurring. Other uses spring readily to mind, such as a power meter and, of course, a VU meter, but its real attraction will be . . what is it . . . a fairly useful something to look at!

At this point it must be stated that the circuit has no pretentions to being a high performance spectrum analyser. The circuit for an instrument of this type is far more complex and would require far more critical components than are used in the design here. However, the performance is surprisingly good and, as the prototypes proved, is accurate to about 5%.

The display consists of ten columns having nominal centre frequencies of 32 Hz . . . 16 kHz. The signal strength is indicated vertically in 14 discrete steps of 1.4 dB. The resulting matrix therefore contains 10 x 14 = 140 points and could be constructed using 140 LEDs. However, the current consumption of a display matrix of this size using LEDs would be fairly high. Construction would be fraught with a few problems and the overall finished appearance would leave a lot to be desired. All these disadvantages are overcome by the use of a fluorescent display that contains the correct number of picture dots (or pixels) and, of course, one such 'animal' does actually exist – the DM4Z from Futaba. With 10 vertical columns of 14 pixels, it could almost have been made to order . . . !

Design fundamentals

The block schematic of figure 1 illustrates the basic sections of the circuit. The incoming signal is divided into 10 frequency bands by the 10 band-pass filters with the centre frequencies mentioned earlier. The output of each filter is followed by a simple rectifying circuit consisting of a diode and a capacitor and then fed to a 10 into 1 multiplexer. The multiplexed output signal is fed to 14 comparator stages which also act as the driver stages for the 14 horizontal lines of the display matrix. A 1 into 10 multiplexer drives the 10 columns of the matrix. Both the multiplexers are clocked with a common clock signal to ensure that they are always exactly in step with each other. This means that the 10 into 1 multiplexer always connects that filter to the comparator stages that correspond to the column selected by the 1 into 10 multiplexer. Therefore a number of pixels in each column will light depending on the conditions of the 14 outputs of the comparator stages. In essence, the number of pixels lit in a column will depend on the voltage level across the capacitor in the rectifier stage following the filter corresponding to that column.

So far so good, but the circuit itself is not quite that simple because we now require 10 band-pass filters, 10 rectifier circuits, 2 multiplexers and their clock oscillator, 14 comparator stages, a power supply and, of course, the display itself. However, before despair sets in, construction is vastly simplified by the use of printed circuit boards.

The band-pass filters

As only ten centre frequencies are to be displayed it is not necessary for the band-pass filters to have very steep slopes. This is definitely an advantage because only the simple active filter circuit shown in figure 2 is required. This is a filter with multiple path feedback in which the Q factor, the amplification and the centre frequency can each be selected by the choice of 3 resistors R1, R2

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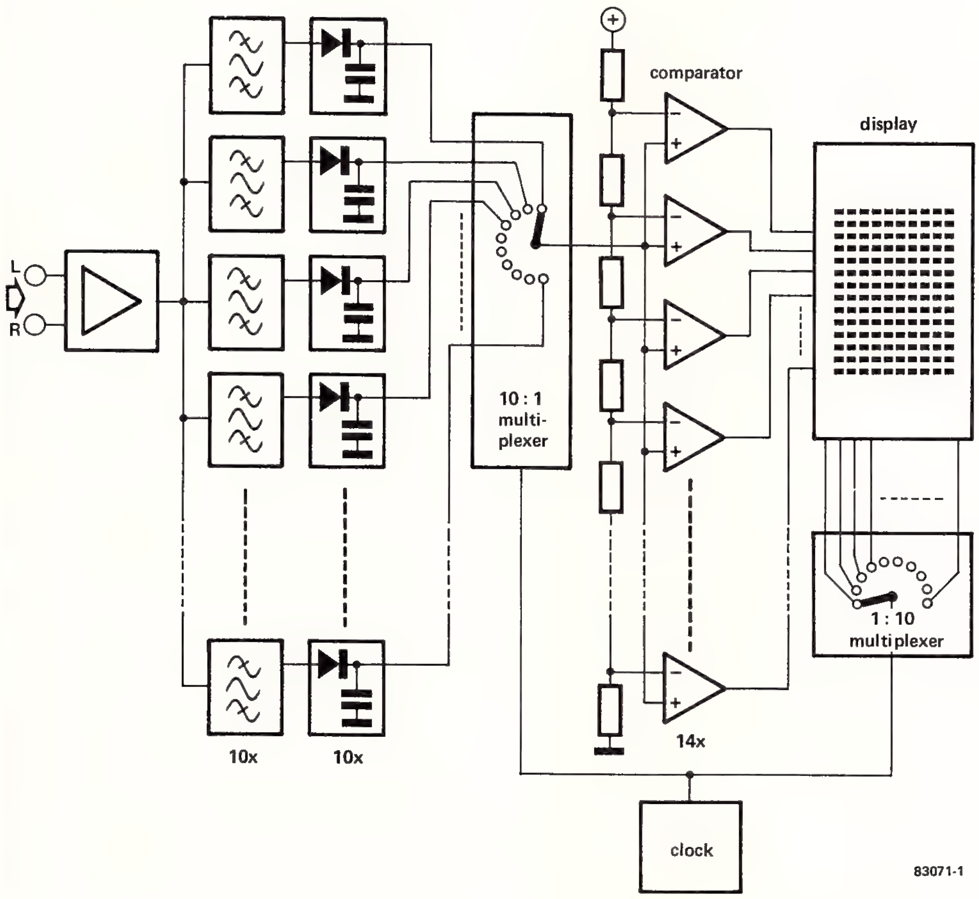

Figure 1. The block schematic diagram of the Spectrum Display. The input signal is divided into ten frequencies by means of band-pass filters, rectified and taken to a multiplexer which feeds the ten voltage levels sequentially to a comparator. The comparator drives the lines of the display while the columns are controlled by a second multiplexer.

and R3, and capacitor C. The formulae for the filter are given in figure 2. The amplification of the filter is set at 7 dB and the Q factor at about 3. No special components are used in the circuit and therefore some small deviation of the centre frequency and the Q factor can be expected but this can be ignored. The frequency response curves for the filters are shown in figure 3.

The circuit diagram

The complete circuit diagram for the spectrum display will be found in figure 4. At first sight it may appear to be rather complex but, as we already know, most of it is just repetition.

The input circuit is formed by op-amp A1 which is arranged as a mixer-amplifier. Both the left-hand and the right-hand signal are connected to the related input terminals: the output of the op-amp then contains the sum of these two signals. It is, of course, possible to connect a mono-signal to one of the two input terminals; the other terminal can remain 'open'. The amplification of A1 can be adjusted between 0 dB and 13.5 dB. At maximum amplification, the input sensitivity of the stage is 90 mV.

The output of A1 is connected to the inputs of the ten band-pass filters, A2 . . . A11. The centre frequency of filter A11 is about 32 Hz, that of A10 around 63 Hz, and so on, until that of A2 is around 16 kHz. The output signals of the filters are rectified and smoothed by diodes D1 . . . D10, resistors R34 . . . R43 and capacitors C23 . . . C32 respectively.

The 10-to-1 multiplexer which follows is a 'discrete' design consisting of ten analogue switches ES1 . . . ES10. These are driven by the output of counter IC13, of which more later. The outputs of all analogue switches are connected together and terminated in R45 and potentiometer P2. The total value of R45 plus P2 determines the discharge time of the capacitor which at any one moment is connected to R45 and P2 via one of the switches. Each of these capacitors could have been given its own discharge resistor, but in this way a saving of nine resistors is made and, in addition, it has become possible to set the discharge time of all capacitors by means of only one potentiometer. The value of the potentiometer determines the decay time of the meter, that is, the speed with which a column drops after an indication.

The multiplexed signal is then taken to a

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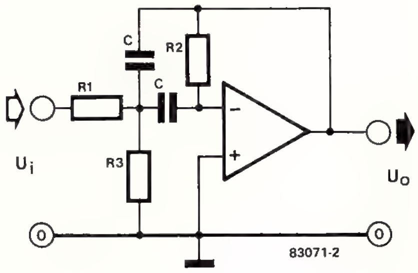

centre frequency : $f_0 = \frac{1}{2\pi C}\sqrt{\frac{R1+R3}{R1\,R2\,R3}}$

gain at f_0: $-A_0 = \frac{R2}{2R1}$

Q-factor: $Q = \pi\, R2\, C\, f_0$

bandwidth: $B = \frac{1}{\pi\, R2\, C}$

Figure 2. This shows the circuit of the active band-pass filter. The centre frequency, the amplification and the Q-factor can all be set separately by the correct values of resistors R1 . . . R3 and capacitor C.

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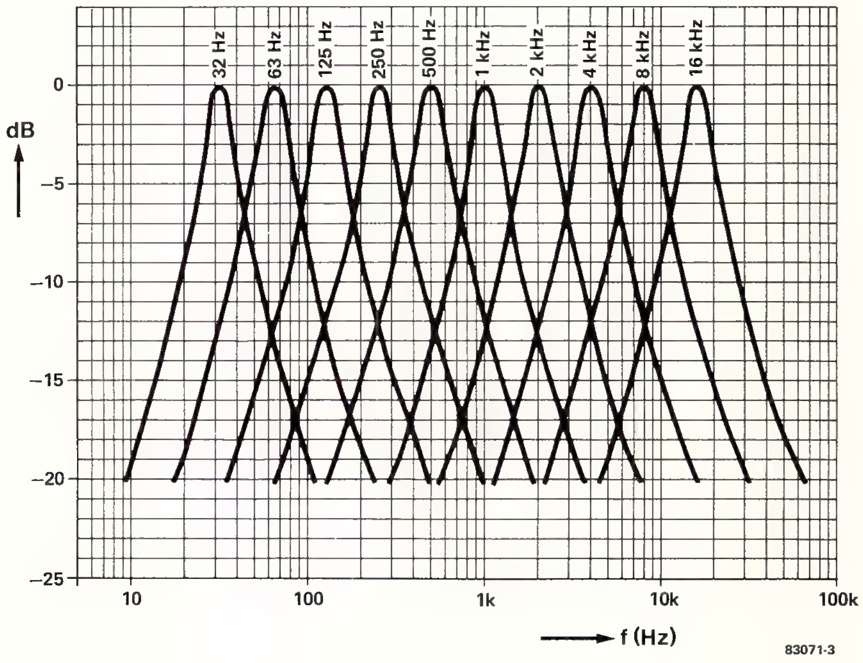

Figure 3. The frequency characteristics of the ten band-pass filters.

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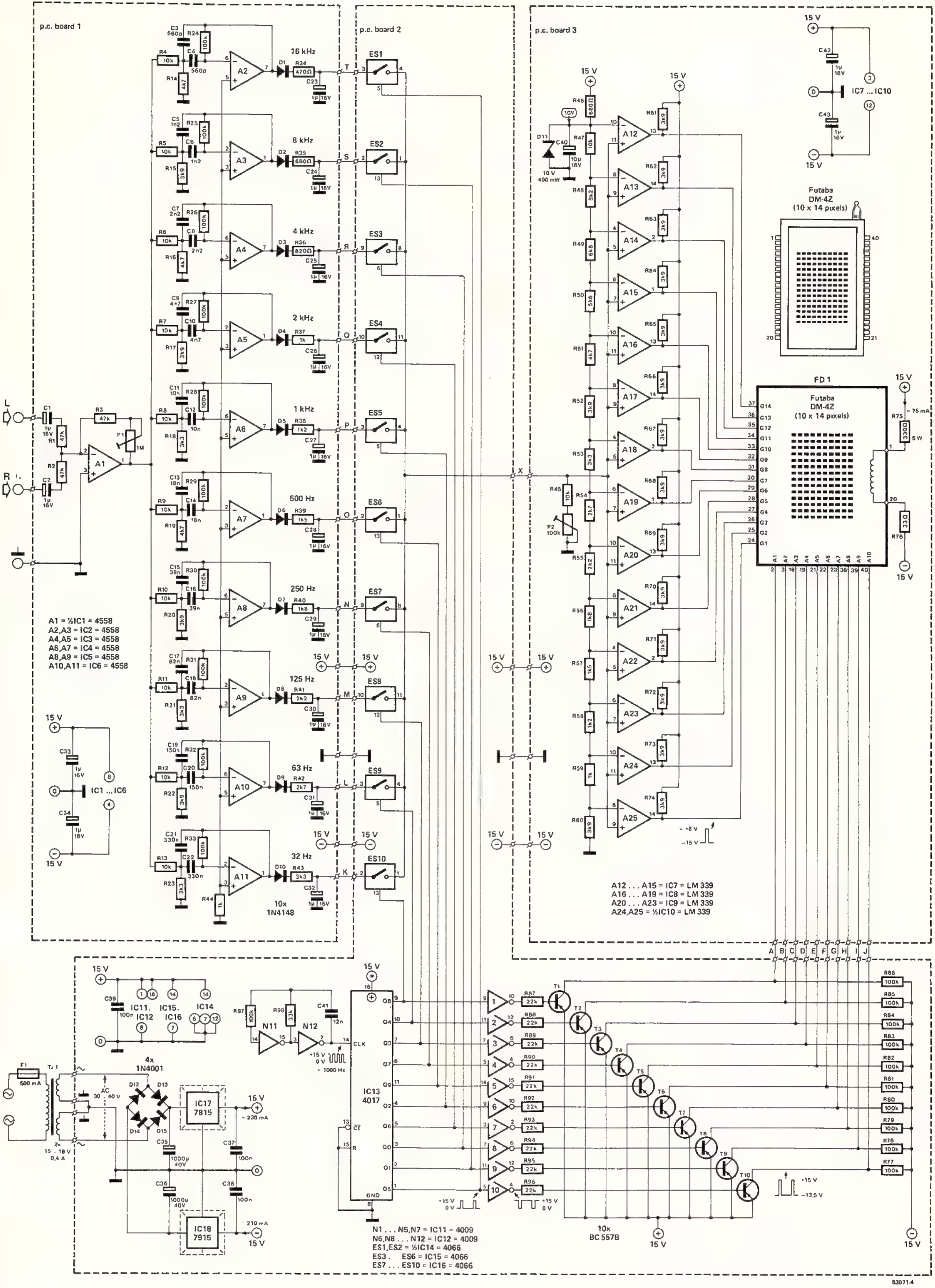

Figure 4. The complete circuit diagram of the Spectrum Display. Which parts of the meter are located on each of the three boards is indicated by the hatched line.

14-stage comparator, A12 . . . A25. The voltage at the non-inverting input of each op-amp, that is the multiplexed signal, is compared with a reference voltage at the inverting input of the amplifier. The reference voltages are derived from 10 V DC which in turn is derived from the 15 V supply by means of R46 and zener diode D11. The reference voltages for the op-amps are obtained from a voltage divider consisting of R47 . . . R60.

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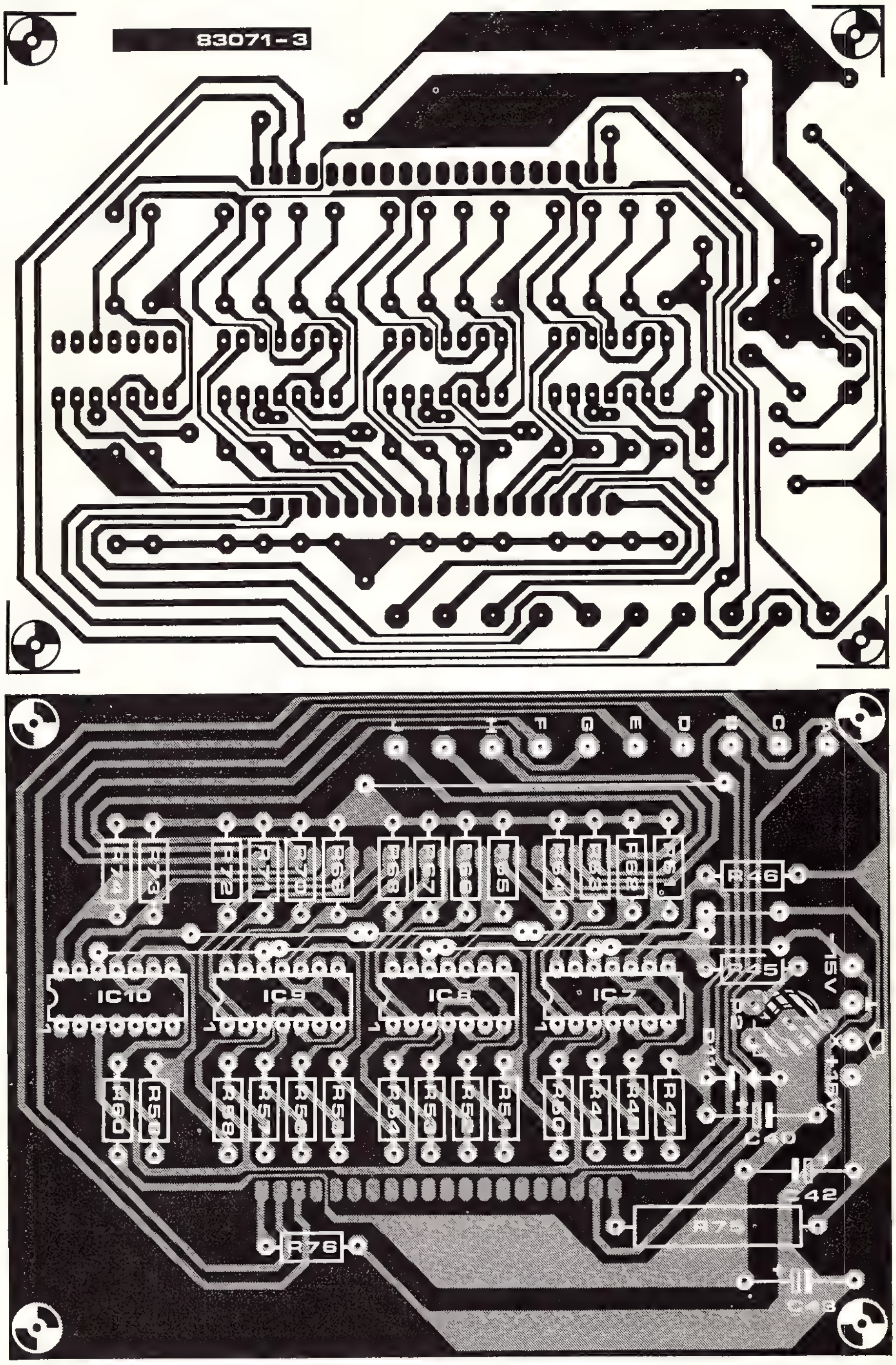

Figure 5. The component layout and track pattern of the printed circuit board for the filters and signal rectifiers.

Parts list

Resistors:
R1 . . . R3 = 47 k
R4 . . . R13,R45,
R47 = 10 k
R14,R16,R19,R51 = 4k7
R15,R17,R20,R22,R52,
R60 . . . R74 = 3k9
R18,R21,R23,R43,
R53 = 3k3
R24 . . . R33, R77 . . . R86,
R97 = 100 k
R34 = 470 Ω
R35,R46 = 680 Ω
R36 = 820 Ω
R37,R44,R59 = 1 k
R38,R58 = 1k2
R39,R57 = 1k5
R40,R56 = 1k8
R41,R55 = 2k2
R42,R54 = 2k7
R48 = 8k2
R49 = 6k8
R50 = 5k6
R75 = 330 Ω/5 W
R76 = 33 Ω
R87 . . . R96 = 22 k
R98 = 33 k
P1 = 1 M preset
potentiometer
P2 = 100 k preset
potentiometer

These resistors are normal, commercial types which results in the logarithmic division not being exactly the same value for each step (the average step value is 1.44 dB, but individual steps may vary between 1.3 and 1.8 dB). For this application, it is not necessary to spend more money on high-precision resistors.

Comparators A12 . . . A25 have an open-collector output which is why each of these outputs is connected to the positive supply line via one of the resistors R61 . . . R74. These resistors should be ¼ W types as their dissipation amounts to .23 W if the output voltage of the op-amp is −15 V. When no input signal is present (0 V at point X), the outputs of all comparators are at −15 V (they are fed symmetrically). This means that all dots of the display are extinguished. If an input signal is present, one or more comparators are inhibited, so that the grids of one or more columns of dots become about +8 V causing the relative dots of those columns to light.

The controlling element in the multiplexing process is IC13 which is wired as a 'ring' counter. This means that a logic 1 travels continuously along its Q0 . . . Q9 outputs at the frequency of the clock counter formed by gates N11 and N12. The '1' appearing at the counter outputs is used to select (or switch on) each of the vertical

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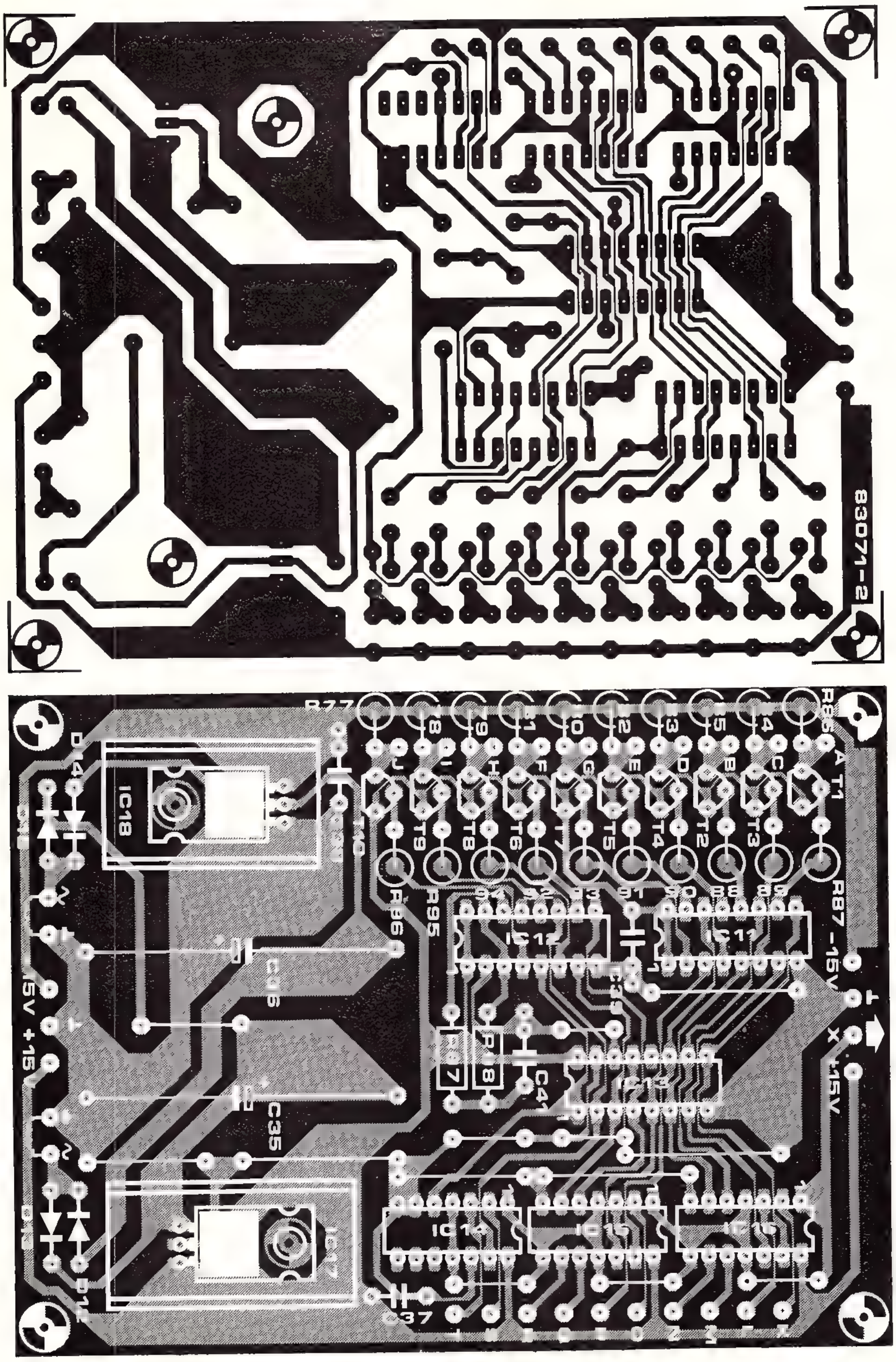

Capacitors:

C1,C2,C23 . . . C34,C42, C43 = 1 µ/16 V
C3,C4 = 560 p
C5,C6 = 1n2
C7,C8 = 2n2
C9,C10 = 4n7
C11,C12 = 10 n
C13,C14 = 18 n
C15,C16 = 39 n
C17,C18 = 82 n
C19,C20 = 150 n
C21,C22 = 330 n
C35,C36 = 1000 µ/40 V
C37 . . . C39 = 100 n
C40 = 10 µ/16 V
C41 = 12 n

Semiconductors:

D1 . . . D10 = 1N4148
D11 = 10 V/400 mW zener
D12 . . . D15 = 1N4001
T1 . . . T10 = BC557B
IC1 . . . IC6 = 4558
IC7 . . . IC10 = LM339, CA 339, µA 339
IC11,IC12 = 4009
IC13 = 4017
IC14 . . . IC16 = 4066
IC17 = 7815
IC18 = 7915

Miscellaneous:

FD1 = DM-4Z Futaba fluorescent display (Regisbrook)
Tr1 = mains transformer 2 x 15 . . . 18 V/400 mA
F1 = 500 mA slow-blow fuse
heat sink for IC17 and IC18 (35 x 20 x 15 mm)

Figure 6. This printed circuit board contains the multiplexers, the column drivers and the power supply. It should be remembered that the heat sinks for IC17 and IC18 must not touch C37 and C38.

columns of the display. However, it can't do it directly since the fluorescent display is in fact switched between 0 and −15 V and some sort of interface is therefore required. This is conveniently taken care of by inverters N1 . . . N10 and transistors T1 . . . T10 which act as drivers and level translators.

The ring counter also drives the analogue switches ES1 . . . ES10. As already explained in the description of the block schematic diagram, these connections are arranged such that at all times only the band-pass filter corresponding to a driven column is connected to a comparator circuit.

Readers may remember the article on fluorescent displays in our March issue in which it was explained that this type of display operates by means of a filament. The filament current is provided by the symmetrical power supply and limited by R75. Resistor R76 ensures a small positive potential difference between cathode filament and anode and grid which prevents unwanted lighting of the pixels.

A simple power supply is required for the +15 V and −15 V levels and for this the usual voltage regulator ICs are used, IC17 and IC18. The supply is capable of providing a current of at best 250 mA.

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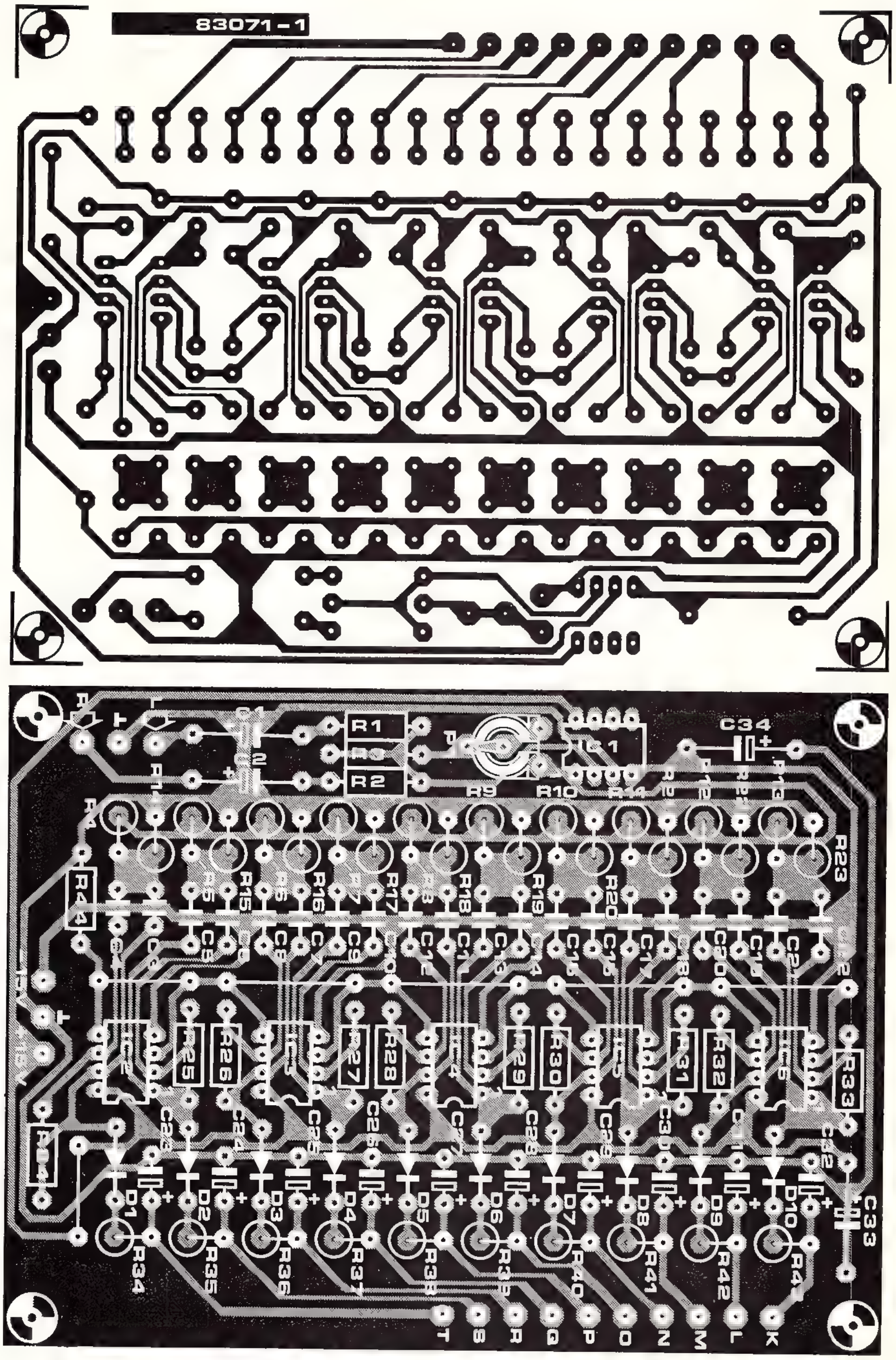


Figure 7. The ten comparators and the fluorescent display are located on this printed circuit board. Both the display and preset P2 are mounted on the foil side of the board.

Construction

The spectrum meter is constructed on three printed circuit boards as illustrated in figure 4. One board contains the filters and rectifier circuits, the second contains the power supply, the multiplexers and the level translators for the column drives, the final board carries the comparators and the display itself. Three boards were decided on in order to keep overall size down to convenient proportions. It also enables separate sections of the circuit to be used for other purposes, or indeed, further additions such as higher performance band-pass filters if desired.

Construction can be started with the components of the power supply circuit on printed circuit board 2. ICs 17 and 18 must be fitted with heatsinks and care must be taken in their choice with regard to physical dimensions. Too large a size will find capacitors C37 and C38 hanging off the board! With just the power supply components mounted on the board, the transformer can be wired up and a check carried out.

The first point to note is that if a transformer with two secondary windings is used it is obviously important that they are wired to the board correctly. This is very easy to check by measuring the voltage across the (total) secondary winding. If the reading is about zero volts then simply reverse the connections of one of the secondary windings. The +15 V and −15 V rails can now be verified.

The remaining components on the board and those on printed circuit board 3 can now be fitted. Resistors R77 . . . R96 are mounted vertically saving a great deal of space. The preset P2 and the display are mounted on the foil side of printed circuit board 3. It will be noted that no holes exist in the board for the display and this is quite deliberate. It effectively prevents the pins of the display from protruding through to the component side of the board and causing all sorts of untoward happenings! Even so, mounting the display will present no problem.

The small nipple (via which the display is evacuated during manufacture) must be located at the side of potentiometer P2. The display is then held in position and one or two pins are soldered to the relative positions on the boards. If the display appears to be sited correctly, all other pins can be soldered. After that, the connections between boards 2 and 3 can be made. The interconnections between A . . . J on both boards are made with short lengths of flexible wire; those between 15 V, −15 V, ⊥ and X can be made with somewhat longer pieces of wire (6 . . . 7 cm). The boards can then be folded apart to give good accessibility (see photo 1).

The time has now come to check whether the display will light correctly. First, P2 is set to maximum (100 k) and then a 10 k potentiometer is connected between +15 V and 0 V. The slider of the potentiometer is connected in turn with terminals K . . . T (in that order). With the slider connected to K, the left-hand column of the display should begin to light when the potentiometer is adjusted for a higher voltage; once the voltage is high enough, all 14 dots of the column should light. When this is found to be working correctly, the other columns should be checked in a similar fashion. When all columns are found to be functioning correctly, it indicates that the display-drive, the multiplexers, the clock and the comparators are in good working order.

The remaining board, PCB1, can now be completed. The capacitors C23 . . . C32 and resistors R4 . . . R23 and R34 . . . R43 are mounted vertically. Then terminals K . . . T, +15 V, ⊥ and −15 V are interconnected: the last three preferably by somewhat longer pieces of wire to enable to boards to be 'opened' as in photo 1.

The complete set of boards can now be fitted together like a double sandwich by means of 4BA threaded rods, nuts and spacers as shown in photo 2.

Finally . . .

. . . some further points to note. The circuit contains two preset potentiometers, aptly labelled P1 and P2! The first is used to adjust the input sensitivity while P2 controls the decay time of the display. Preset P2 was deliberately positioned just above the display (and on the foil side of the board) to enable the decay time to be adjusted through a small hole in the front panel above the display window. It is also, of course, possible to use full size potentiometers in place of the presets and mount them on the front panel. It is strongly advised that a screen of some sort is used for the display window. A piece of green perspex for this would probably present the best appearance. In the event that the completed Spectrum Display is too large to be fitted into a desired space, it is possible to mount the display remotely from the circuit boards. An appropriate length of 26 way ribbon cable would be ideal for the interconnection between the boards and the display.

Where is the input connected to? If possible it would be best to use the tape – record – monitor output of the preamplifier where the output level remains fairly constant and is independent of the various controls of the preamplifier. This has the advantage that the input sensitivity of the Spectrum Display need only be set once. If the signal is taken from the preamplifier outputs to the power amplifier stage (the so-called pre-power link) it will be necessary to adjust P1 every time the volume level is altered. Not a happy situation!

It is, of course, possible to build a 'stereo' Spectrum Display. This simply consists of two independent Spectrum Displays and uprating the transformer to an 800 mA type. The two circuits are then fed from the two channels of the tape record output of the preamplifier.

Now for Quadrophonic . . . but thats going a bit too far! ◼

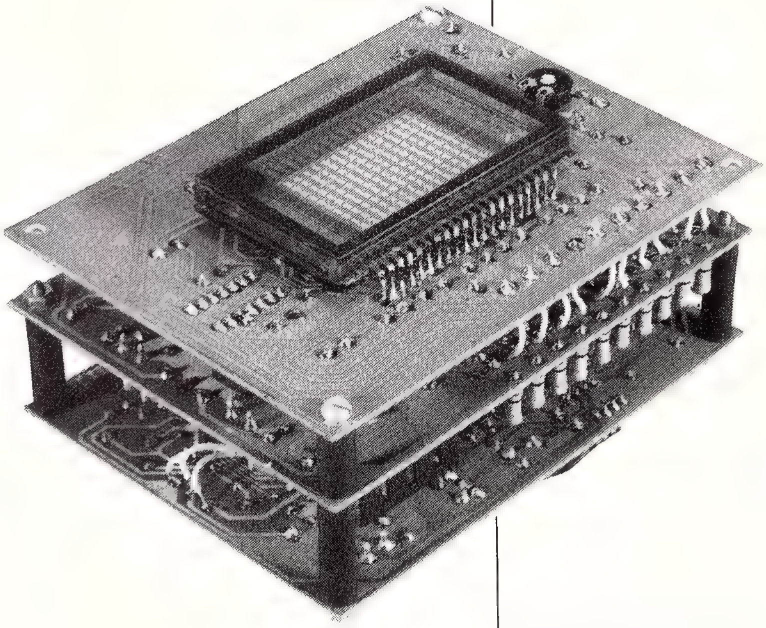
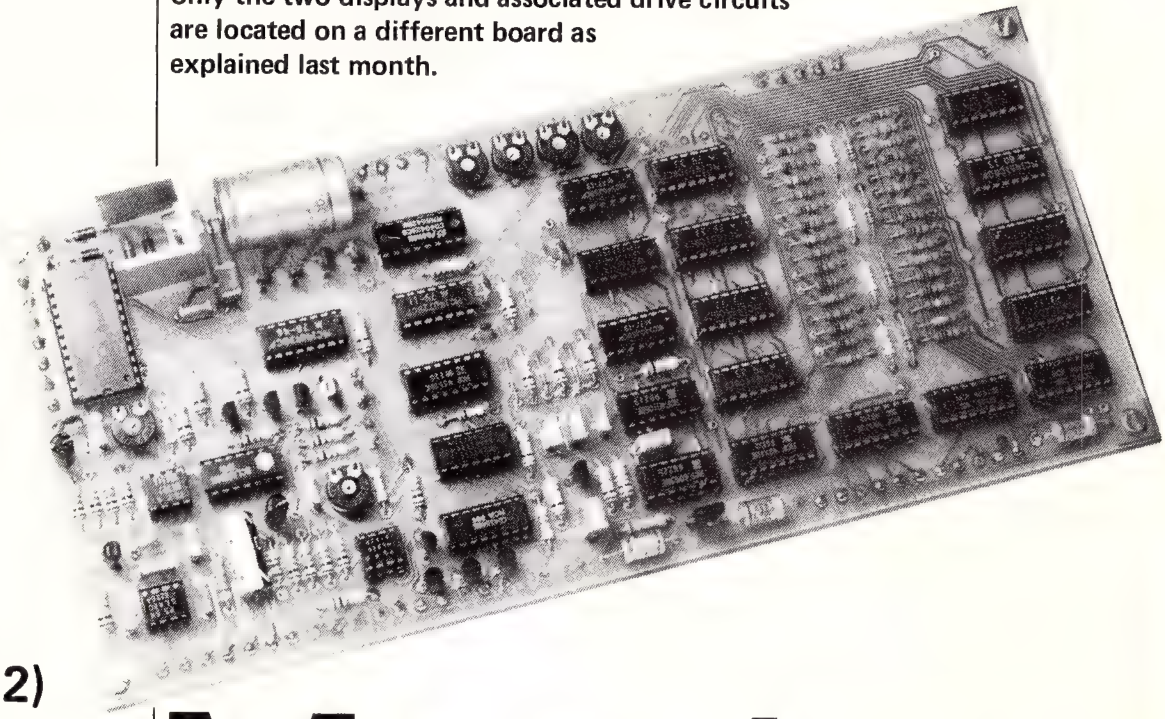


Photo 2. The final construction of the Spectrum Display is illustrated here. It is also possible to mount the display remotely if desired.

Following the description of the complete Maestro remote control and the construction of the transmitter in our May issue, we continue with the construction, fitting and adjustment of the receiver. Virtually the complete receiver is contained on a double-sided printed circuit board; only the two displays and associated drive circuits are located on a different board as explained last month.



(part 2)

Maestro

the receiver board

The receiver board is not small, but in view of the complexity of the circuit that is not unexpected: after all, it contains 29 IC's, 15 transistors, 9 diodes and a fair number of resistors and capacitors. The board is shown in figure 1. It is advisable to check the through-plating of the holes (with a resistance meter) before any other work is commenced, because any faults are virtually impossible to find once the board has been soldered.

Construction

After the board has been checked thoroughly, the components can be mounted. All IC's should be fitted in good-quality sockets.

Capacitors C22 and C23 are mounted vertically. The two 7-segment displays and associated driver circuits, resistors and decoupling capacitors are located on the display printed circuit board, the design of which was dealt with in last month's issue.

As explained last month, IC14 can be omitted if the 'extra' functions are not required. If this is the case, IC15, T7 . . . T10, T15, R42, R44 . . . R50, D8 . . . D11, and half of the keyboard for the transmitter (or the 'function select' key) can also be left out. Where T15 would have been located a jump wire must be soldered between the emitter and collector connections.

In part 1 it was described how the display board should be fitted behind the front panel. This board can be connected to the receiver board by an 11-way ribbon cable. The LEDs are connected to the printed circuit board by ordinary single-core insulated wire; D4 . . . D7 have a common cathode connection, D8 . . . D11 a common connection to the + line, and D12 . . . D15 have a common anode connection. The volume counter on the receiver board should be preprogrammed by four jump wires. Note that as this is a CMOS device, none of its inputs should be left floating as this might cause the device to burn out. The receiver diode, which is located behind the receiver window, is connected to the board by two short pieces of wire.

If the power outputs to other equipment are to be used, three relays, Re1 . . . Re3 are needed to switch the mains supply. Diodes D_X, D_Y and D_Z should be connected directly to the coils of the relays. The relays can be fitted in the case of the Maestro or in the equipment to be powered (where they continue to be driven by the low power signals from the Maestro). The maximum permitted current per relay is 100 mA.

As regards the tape recorder connections, Q1 . . . Q7, there is no cut-and-dried universal layout that will suit every tape recorder. Some tape recorders work by setting some lines to ground, while others connect the relevant lines to +24 V. So there is only one

**A word to Prelude constructors:
Printed circuit board designs for the buffer stages described in our May issue will be published in the July/August 'Summer circuits' issue.**

1

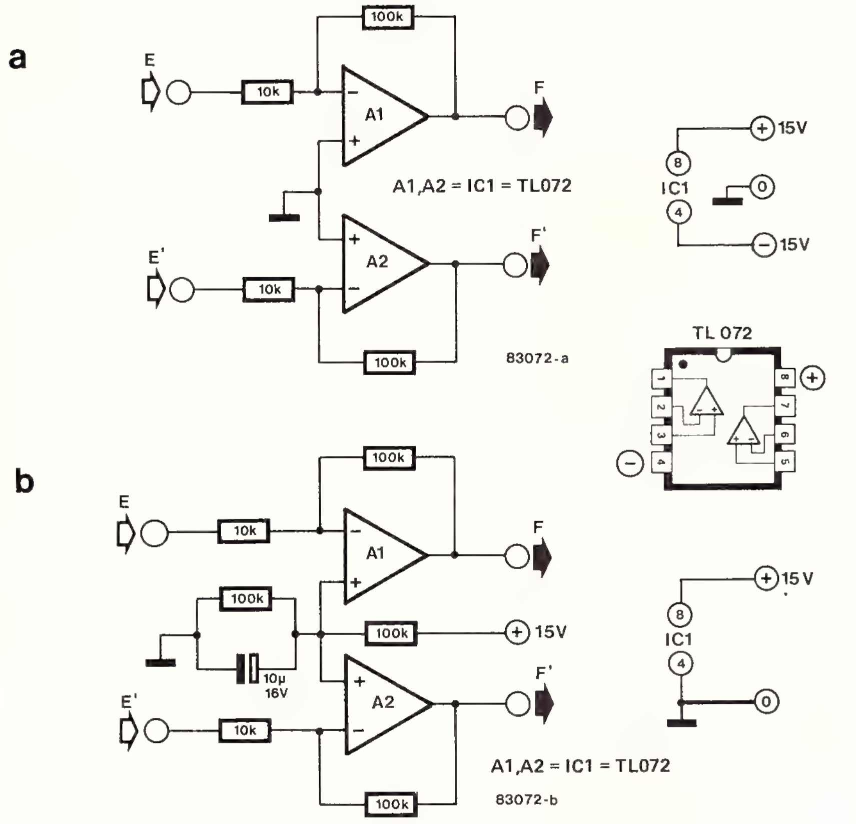


Figure 1. If the Interlude is used without the Prelude, an extra stage of amplification is required. The circuit of such a stage for use with a 15 V symmetrical supply is shown in 1a; in all other cases the circuit of 1b should be used.

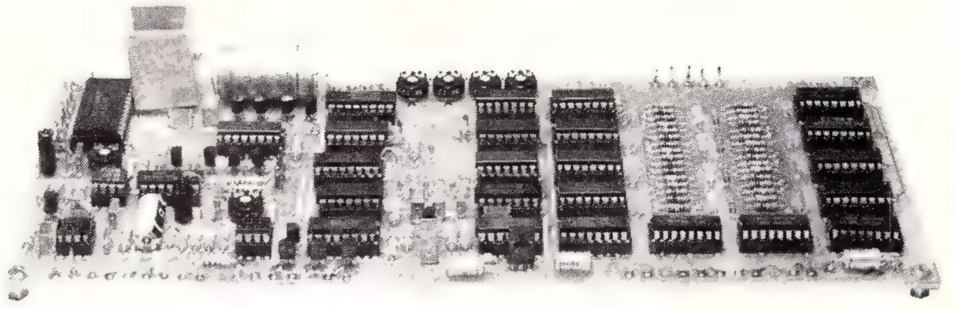
answer to this problem: have a look at the circuit diagram of the tape recorder which is to be controlled and see how each particular function (play, fast forward, record, and so on) is controlled. It may be necessary to design a small interface between the Maestro and the tape recorder. Note that the Q outputs are all logic 1 (+15 V) when the corresponding key is pressed and that these outputs can only deliver a few milliamperes.
Finally, a connector is needed for linking the receiver with the Interlude pre-amplifier. This connector must have at least 9 pins and the sensible thing to do is to use the same kind as is used for the Prelude. The connector is fitted at the rear of the Maestro case and a 9-way ribbon cable used to link the Prelude and Maestro.

Adjustment

Before the Maestro can be used, a few potentiometers must be preset.
After switching on the mains, press the 'on' button to make sure that the unit is not on stand-by. To tune the receiver to the transmitter frequency first set potentiometers P1 and P2 to their mid-positions. Use the remote control to increase and reduce the volume. Turn P1 slowly until a position is found where the display correctly follows the operations of the push buttons (that is, the count on the display increases or decreases immediately the volume up or down button is pressed). Then, watch LED D9 and while pressing the 'power 1 on' and 'power 1 off' buttons alternately, adjust P2 such that the LED reacts properly to which button is pressed.
Next, the output voltages of the D/A converters must be set. Connect the Maestro to the Prelude/Interlude and set potentiometers P3 . . . P6 to their minimum positions. Then set all counters – volume, balance (tone) high and low – to 99 after which the remote control should not be touched until the adjustments have been completed. Connect a voltmeter between test point TP on the Interlude board and output H of the Maestro. Adjust volume control P3 slowly until the potential difference between TP and H is 0 V. Similar adjustments are made with the voltmeter between TP and outputs K, M and L and adjusting balance control P4, (tone) low control P5 and (tone) high control P6 respectively. Once these adjustments have been made, the voltages between each of these outputs and ground should be about 5.4 V. The Maestro can then be boxed up.

Interlude and Maestro

Some readers may want to use the Maestro and Interlude, but not the Prelude, which is, of course, possible but a small circuit will then have to be added on the Interlude



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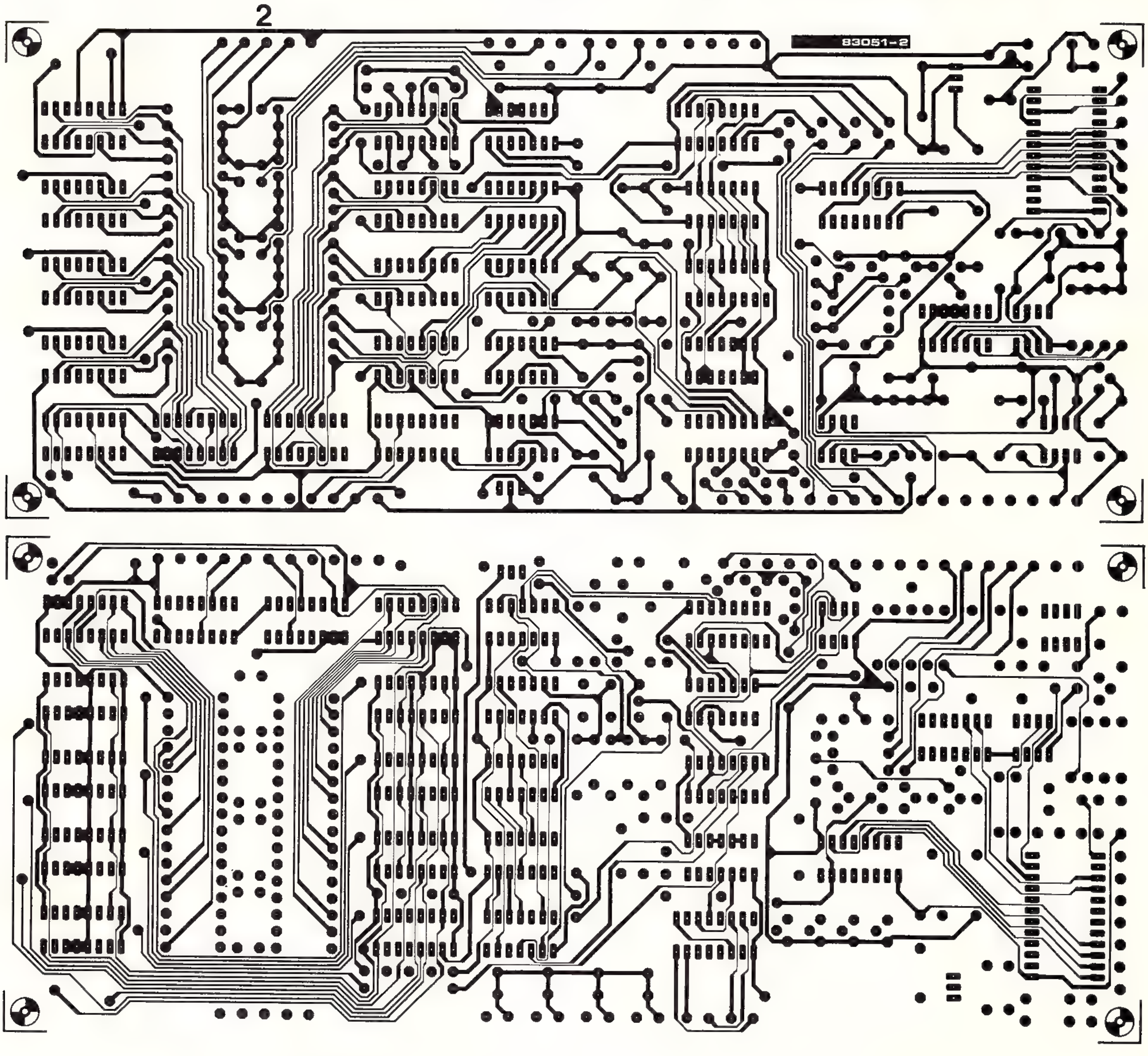


Figure 2. The printed circuit board for the receiver is double-sided with plated-through holes. Its size is an unavoidable consequence of the large number of components used.

printed circuit board, provided that the power supply can additionally deliver 15 V at 100 mA.

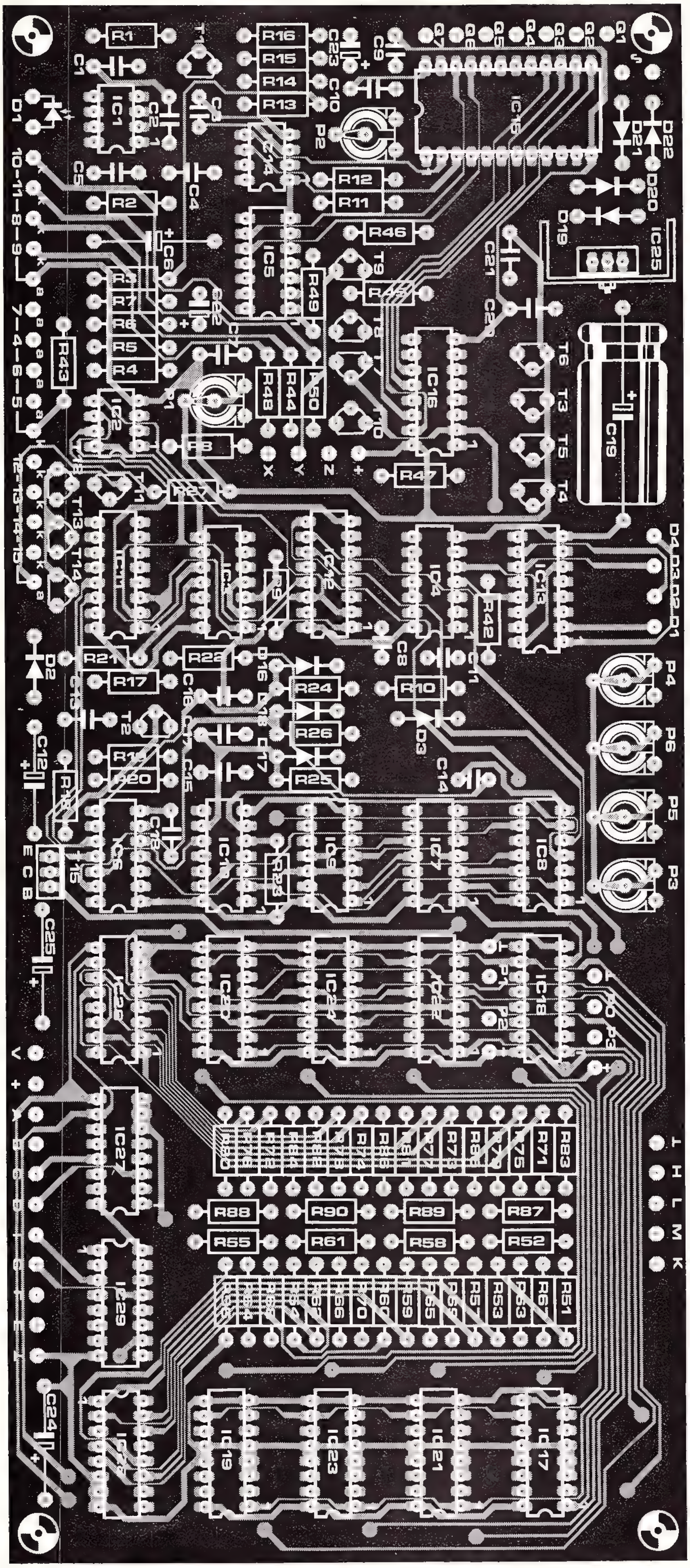
As the Interlude is a unity gain amplifier, an additional voltage gain of 10 is required to obtain an output of 1 V for an input of 100 mV. A suitable circuit for use with a symmetrical supply of ± 15 V is shown in figure 1a; if such a supply is not available, the circuit of figure 1b must be used.

The additional amplifier stage is connected between points E and F and E' and F' on the printed circuit board after resistors R23 and R23' have been removed and resistors R17, R17', R24 and R24' have been replaced by jump wires. The op-amps can be type TL 072, TL 082, RC 1458, RC 4558.

The inputs for tuner, tape and auxiliary can be connected directly to the input bus. Points D1 . . . D4, H, K, L and M are connected to the Maestro by a suitable ribbon cable.

The Interlude and Maestro can be built into one common case but that is a matter of personal choice.

That finishes the construction and presetting of the Maestro; all that remains is to enjoy it!



Parts list: Receiver

Resistors:

R1,R9,R10,R11,R17,
R19,R22,R23 = 100 k
R2 = 82 k
R3 = 560 Ω
R4 . . . R7,R13 . . . R16,
R27,R43,R44,
R48 . . . R50 = 1 k
R8,R12 = 47 k
R18 = 560 k
R20 = 1 M
R21 = 4k7
R24 . . . R26 = 10 M
R42 = 22 k
R45 . . . R47 = 10 k
R51 . . . R62 = 1 M/1%
R63 . . . R66 = 499 k/1%
R67 . . . R70 = 249 k/1%
R71 . . . R74 = 200 k/1%
R75 . . . R78 = 100 k/1%
R79 . . . R82 = 49k9/1%
R83 . . . R86 = 24k9/1%
R87 . . . R90 = 15 k
P1,P2 = 100 k preset
potentiometer
P3 . . . P6 = 5 k (4k7)
preset potentiometer

Capacitors:

C1 = 47 n
C2,C4,C15,C21 = 100 n
C3 = 82 p
C5 = 2n2
C6 = 47 µ/25 V
C7,C10 = 22 n
C8,C14 = 22 p
C9,C11 = 100 p
C12,C24,C25 = 10 µ/16 V
C13 = 470 n
C16 . . . C18 = 220 n
C19 = 1000 µ/40 V
C20 = 330 n
C22,C23 = 1 p/16 V

Semiconductors:

D1 = BP 104
D2,D3,
D16 . . . D18 = 1N4148
D4 . . . D15 = LED red
D19 . . . D22,
D_x,D_y,D_z = 1N4001
T1 = BC 560
T2 . . . T6,
T8 . . . T10 = BC 547B
T7,T11 . . . T14 = BC 557B
T15 = BD 679
IC1 = SL 480
IC2 = ML 926
IC3 = 4011
IC4 = 4072
IC5 = 4002
IC6 = 4093
IC7 = 4001
IC8,IC9 = 4025
IC10 = 40106
IC11 = 4556
IC12 = 4555
IC13 = 4042
IC14 = ML 927
IC15 = 4514
IC16 = 4043
IC17 . . . IC24 = 4510
IC25 = 7815
IC26 . . . IC29 = 4052

Miscellaneous:

Tr1 = transformer,
15 V/0.8 A secondary
Heatsink for IC25
3 x relays, 12 . . . 15 V,
100 mA max.

The rapidly growing popularity of Video has resulted in an ever increasing string of requests to provide articles for the new band of Video enthusiasts. It is an even more interesting area now that the price of a good video camera is reaching more affordable levels. However, it is a relatively new field and good ideas and circuits take time to formulate.
The article here is pointed in the right direction and is aimed at readers who find an interest in making their own video recordings. The circuit enables certain video tricks or special effects to be used in a video recording and provide an extra dimension that can make a lot of difference.

from an idea by
L. Heylen

video effect generator

box of tricks for video enthusiasts

It is not easy to describe the effects which can be obtained with this generator. It gives the pictures a more 'graphic' character as it were. But that is not the only thing. Depending upon how the generator is adjusted, the effects achieved are reminiscent of trick photography.
What is the idea behind this box of tricks? Well, mainly the dividing of the normally continuously variable brightness of the screen into four fixed values of brightness. The result is, therefore, not just a black and white picture, but additionally two grades of grey, analogous to a digitalisation of the brightness and contrast.
A second feature, which is virtually forced as shall be seen later in the article, is the separate adjustment of brightness and colour saturation. The brightness and colour information are split in the early stages and combined again in the later stages of the circuit; the combining can be achieved in a proportion which is under the control of the operator. By choosing deliberate disproportions, grotesque effects are obtained.
An important remark before technical details are gone into; the input and output of the generator are tuned to standard video signals and it is therefore possible to insert it anywhere in the video chain.

Operation

As usual, the principle of the circuit is best explained with the aid of a block diagram as shown in figure 1.
The video input signal is split into two parts: one part is passed to a colour filter and amplifier, which will be dealt with a little further on, and the other to a four-stage comparator via a buffer. The comparator arranges the (pre-settable) splitting of the brightness into four levels. The processed signal is then passed to a mixer which re-combines the colour and brightness information.
At first sight it may appear unnecessary to filter out the colour information, only to add it again at a later stage, but there is a good reason for this. If the colour were not filtered, the four-stage comparator would also affect the colour information. The sync signal is protected likewise for the same reason: a sync separator takes the sync signal from the buffer and applies it to a second mixer stage where it is re-combined with the rest of the signal.

1

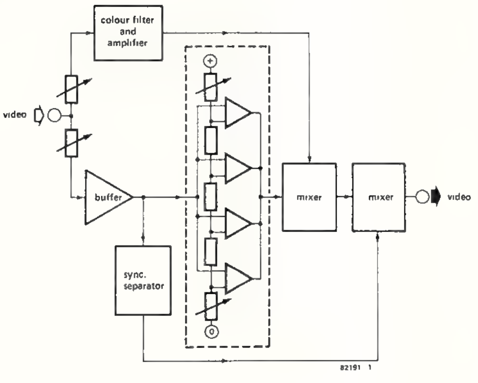


Figure 1. Block schematic diagram of the video effect generator. The information contained in a video signal is dissected into information regarding the brightness, information as to colour and information about the synchronisation. After the brightness information has been processed, the three bits of information are re-combined in two mixer stages.

Circuit description

The blocks shown in figure 1 can be recognised in the circuit diagram of figure 2: A1 is the buffer with input derived via LEVEL control P1 and its output applied to comparators K1 . . . K4. The comparators divide the originally continuously variable brightness into four fixed levels.
The sync separator is formed by comparator K5. Clamping diode D1 ensures that the output of A1 is always positive with respect to the reference voltage of comparator K5. The sync signal lies roughly in the bottom quarter of the video signal and is separated from it by K5. Diodes D2 . . . D5 and potentiometers P3 and P5 form the preset reference voltage supply for the four-stage comparator.
Transistor stage T3 is the colour filter and amplifier; its input level is set by potentiometer P2 and its output is taken to the inverting input of mixer A2. This stage filters and amplifies frequencies in the range 4.43 ± 1 MHz. The amplification is necessary to ensure retention of the information of the original signal.
The four-level output of comparators K1 . . . K4 is also applied to mixer A2 and there mixed with the colour signal from T3. The output of A2 is applied to a second mixer, T2, together with the sync signal from comparator K5.
The output of the generator is best connected

2

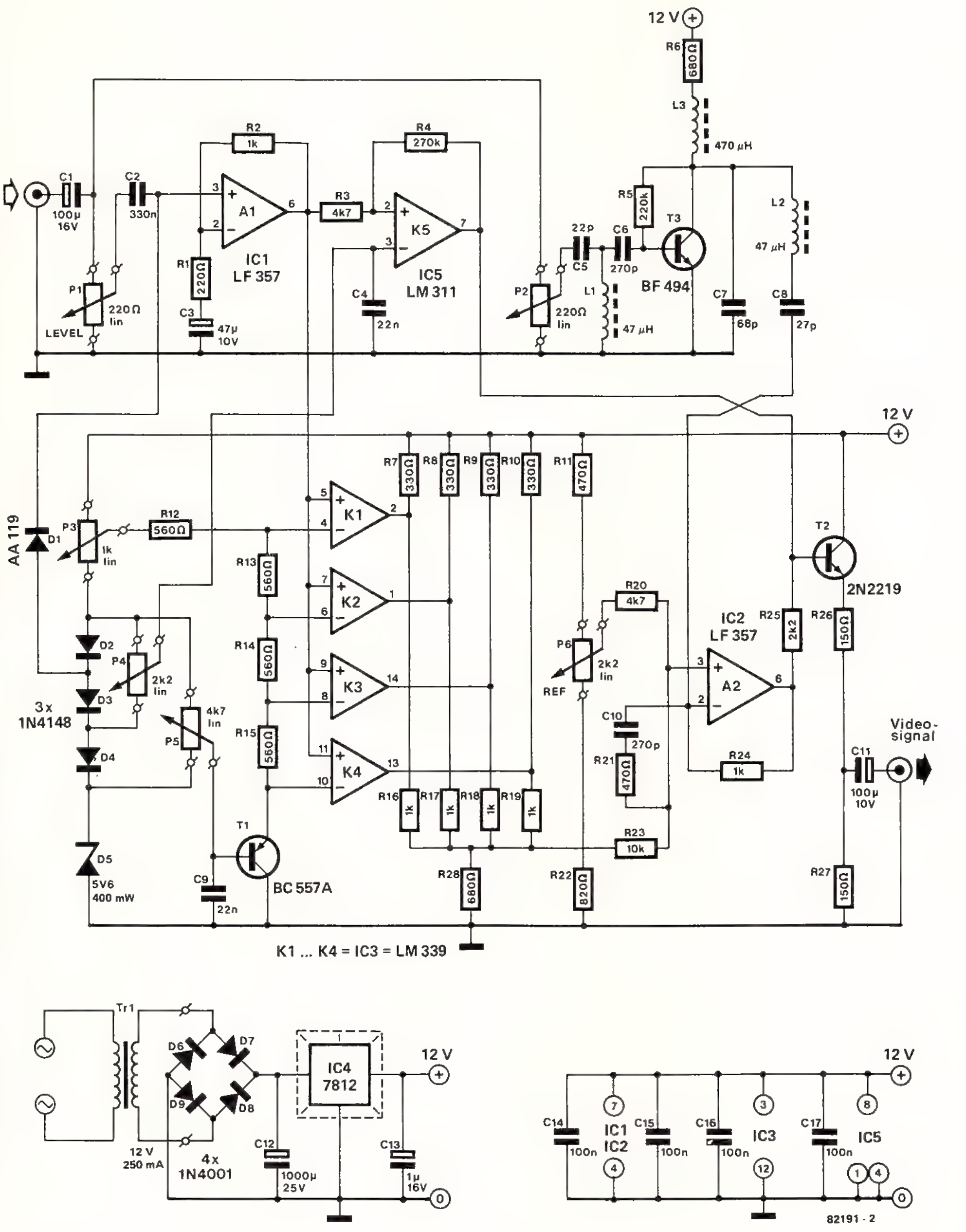


Figure 2. Circuit diagram of the video effect generator. The change of continuously variable to (four) fixed level brightness control takes place in comparators K1 . . . K4. Synchronisation signals are separated by K5, while T3 separates and amplifies the colour information. The complete video signal is reconstituted in mixers A2 and T2.

to the video input of a television receiver, but if such an input is not available, it can be fed to the aerial input via a VHF/UHF modulator.

Adjustment

The functions of the various potentiometers are;

P1 = setting of the input level (sensitivity);
P2 = setting of the colour saturation;
P3 and P5 = setting of the reference voltage for comparators K1 . . . K4;
P4 = setting of the reference voltage for comparator K5;
P6 = setting of operating point of mixer A2.

1. Set all potentiometers to their mid position.
2. Connect the generator to the television receiver and switch on the mains supply.

The input signal should preferably be a test card.

3. Adjust P4 until the picture on the television screen is still.
4. Set the reference voltage for K1 . . . K4.

If four levels are not attainable, the input signal is too weak and the input sensitivity should be increased by P1. If the picture quality is poor, this may be due to overloading: the input level should then be reduced by P1.

5. Increase the input signal by means of P1 and adjust P6 to that position where the largest possible input signal can be processed without undue distortion.
6. Finally, set the required colour saturation with P2. ◆

NOTE: After every change of input sensitivity, it is recommended to readjust the sync level with P4.

morse and radio teletype (RTTY)

This article gives a theoretical introduction to the RTTY decoder featured elsewhere in this issue. It describes the principle of morse-telegraphy and RTTY in some detail; their advantages and disadvantages are considered carefully as are other not so well-known technical features. Advanced radio amateurs and listeners will find many useful hints while others may be tempted by that fascinating hobby which brings the whole world into their homes: listening to morse and RTTY messages on short waves!

all about those dots, dashes and pulses

Apart from radio telephony, that is, the spoken word, there are other 'wireless' ways of conveying a message: radio telegraphy (morse) and radio teletype (RTTY). It all started with telegraphy and it is still true today that radio communication over long distances is more reliable by morse and RTTY than by telephony: in situations where the spoken word becomes unintelligible through interference or other circumstances, telegraphic or RTTY signals can often still be received satisfactorily.

Some history

The first wireless experiments by Marconi at the turn of the century were carried out with the use of the dot-and-dash code invented by Samuel Finlay Morse in 1843 and since called after him, morse code. The idea to represent letters and numerals by a dot or a dot-and-dash code was, however, not first thought of by Samuel Morse, because messages were conveyed by the rhythmic interruption of light and smoke signals hundreds of years before he was born. It was he, however, who first used the idea in telegraphy by wire and it was also he who devised a usable alphabet and number system in morse code (see figure 12).

Radio teletype was born from the need for greater speed in the conveying of messages and that for decoding and typing of received message automatically; morse was not really suitable to meet these needs. But then, morse was intended for hand-operation, easy recognition and to be learnt fairly quickly by operators; clearly, Samuel Morse did not consider automation.

In teleprinter codes, unlike the Morse code, each combination of characters forming a letter, numeral, punctuation mark and so on, is of the same length as measured in units (often called bits but this can give rise to confusion with the binary digit) or in milliseconds of time.

The difference between morse telegraphy and RTTY

The main difference between morse telegraphy and RTTY lies in the timing: morse is characterized by so-called relative timing, RTTY by absolute timing. In morse operation, the proportion between dots and dashes, between dashes and pauses, and between dots and pauses is all-important. The absolute length of the dots, dashes and pauses depend on the proficiency of the operator. Small deviations from the standard lengths do not matter, because the operator 'at the other end' recognises the pattern.

In RTTY this is completely different: the timing is fixed, in other words, the length of the units is accurately known and does not vary. As will be seen later, this is of paramount importance for the satisfactory functioning of automatic (mechanical or electronic) decoders.

When RTTY equipment was first used, it soon became apparent that switching the carrier on and off in the rhythm of the code was far from ideal. Because the most frequently used code, even today, is based on 5 units and all combinations of these have a meaning, errors can easily occur.

Frequency shift keying

To eliminate as many of these errors as possible, frequency shift keying (FSK) was introduced. In this system the carrier frequency has two values: the first (normally higher) frequency is called a mark and represents logic 1; the second (normally lower) frequency is called a space and represents logic 0. The difference between the two frequencies is called the frequency shift.

Frequency shift keying can be considered as amplitude modulation of a carrier, where the modulating signal is a square wave and the depth of modulation is 100 per cent.

A square wave consists of a sinusoidal fundamental and harmonics, in which the ratio of the harmonics depends upon the duty cycle of the square wave. A symmetrical square wave has only odd harmonics. The frequency spectrum of a carrier amplitude modulated by a symmetrical square wave to a depth of 100 per cent is shown in figure 1. It is immediately clear that steps have to be taken to limit the bandwidth. In practice this is achieved by connecting an

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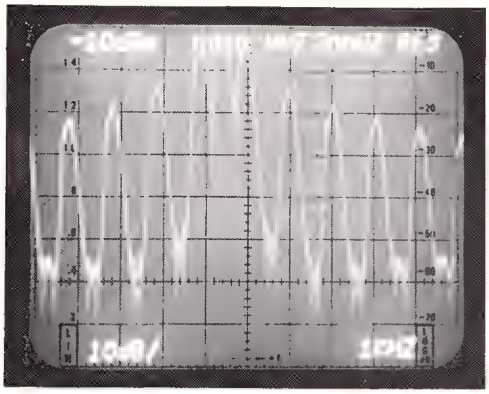

Figure 1. Frequency spectrum of a carrier amplitude-modulated by a symmetrical square wave of 1 kHz to a depth of 100 per cent.

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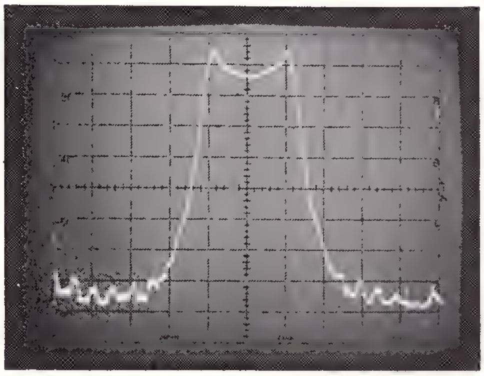

Figure 2. Frequency spectrum of a carrier frequency-modulated by a sine wave of 10 Hz at a deviation of 100 Hz.

3

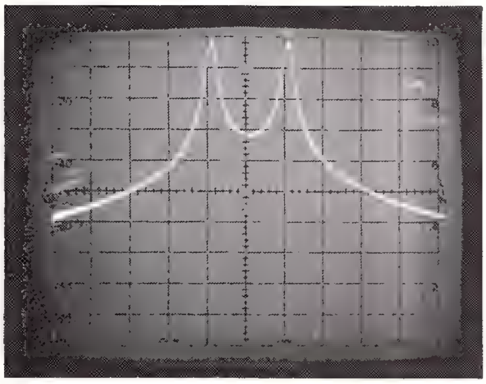

Figure 3. Frequency spectrum of a carrier frequency-modulated by a square wave of 10 Hz at a deviation of 100 Hz.

RC-filter between the key and transmitter. Transmitters with too broad a spectrum are recognisable by the key-clicks, in the rhythm of the code, just off-tune.

The spectrum of a frequency-modulated carrier is shown in figure 2. The modulating signal is a sine wave of 10 Hz and the deviation is about 100 Hz. It is evident that the greater part of the energy lies between $f_c - f_d$ and $f_c + f_d$, where f_c is the carrier frequency and f_d is the deviation. The frequency shift is twice the deviation.

What happens when the modulating signal is changed from a sine wave to a square wave can be seen in figure 3, from which it is clear that the peaks are much better defined than in figure 2. The reason for this is that the transit time from logic 1 to 0 or vice versa is very short, so that little energy is transferred in the region $f_c \pm f_d$. The slopes of the signal are, however, less steep than with sine-wave modulation, so that steps need to be taken to make the bandwidth acceptable. This can be done in two ways: either by a band-pass filter or by rounding the slopes of the modulating signal.

It is seen from the above that FSK can be considered as a carrier which is frequency modulated by a square wave or as a combination of two carriers which are switched on and off sequentially. The second consideration is perfectly acceptable as long as the modulation index (the ratio of the frequency deviation to the frequency of the modulating signal) is greater than 1. This can be seen from the illustration in figures 4 . . . 6.

Demodulation of morse telegraphy and RTTY signals

The reliability of morse telegraphy is directly proportional to the proficiency of the operator. An experienced person can 'copy' a garbled message which would be incomprehensible to a novice, and in this respect an electronic circuit can be considered a novice. The human brain, with its enormous store of information, can, even when there is doubt, more often than not reach the correct conclusion. Human beings also make use of an important property of language: redundancy, which means that there is normally more information available than is necessary to come to a decision or understanding. In other words, even when some of the information is missing, the rest will still enable us to understand the original message perfectly. These human characteristics make morse telegraphy, in spite of all that has been said, the cheapest and most reliable but one method of wireless communication (the repeat request – RRQ – radio teletype system described later in this articles is more reliable than morse operation).

The block diagram of a typical morse telegraphy demodulator is shown in figure 7; it consists of a band-pass filter, an amplifier, a rectifier and a trigger. Automatic gain control (AGC) is also often incorporated. The circuit of such a demodulator presents certain difficulties. The filter should have a pass band of the order of 100 Hz and filters with such steep-sloped characteristics are fairly complicated and thus costly. The most suitable filters are built from delay elements. The delay, that is the time taken by the signal to pass through the element, is frequency dependent. At the centre frequency of such a filter each element delays the signal by one half cycle. After passing through two elements, the signal at that point is in phase with the input signal and if these are added together, there is effective amplification of the original signal. At frequencies where the two signals are 180° out of phase, adding them together would cause effective attenuation. Thus, by careful choice of the delay elements, any desired selectivity can be achieved.

The great advantage of this technique is the ability of the delay elements to block spurious signals effectively; the signal is gradually 'built up' in the filter, whereas unwanted signals are too short for any build up to take place. As the signal takes a finite time to pass through the filter, its frequency should not change during this time, otherwise the aimed-for phase relationship will not be achieved. These filters will soon be available in digital form as integrated circuits.

For the detector a diode circuit will suffice if the filter has good selectivity, although synchronous demodulation is better because of its greater immunity to interference. Such demodulation is normally effected by a phase-locked loop (PLL) which has a dynamic characteristic of not less than 30 dB: this makes AGC superfluous.

The trigger circuit must differentiate between signals of high and low logic levels. To reduce the effects of spurious signals, the detector output should be integrated. The circuit will only trigger if the signal lasts long enough to cause a logic 1. The use of a voltage or current controlled integrator enables the integration constant to be defined by a microprocessor on the basis of the speed of the received signal.

Frequency or amplitude modulation?

RTTY was initially taken as consisting of frequency-modulated (FM) signals and was therefore demodulated in a discriminator. It was argued that this would result in an improvement of the output signal exactly as FM broadcast reception sounds much better, in general, than AM. Nowadays, this argument is accepted by only a small minority.

In the high-frequency bands (1.6 . . . 30 MHz), propagation phenomena occur which affect the path times of a transmission (one path, for instance, is reflected by the E layer of the ionosphere, another by the higher F layer). One of the effects of two waves of the same signal traveling by two different paths to the receiver is interference fading. Another effect is that of selective fading which occurs when some frequencies are more attenuated than others due to phase-shifting.

FM signals suffer quite badly from these effects ans this is worsened by increasing the frequency deviation, which is often done because FM theory is that the gain in signal to noise ratio is directly proportional to the frequency deviation/baud rate ratio.

Photographs taken from a spectrum analyzer show that, in most cases, it is more correct to treat FSK as a combination of two keyed carriers. The narrow bandwidth then depends only on the baud rate and no longer on the frequency deviation; at the same time it ensures greater rejection of spurious signals.

4

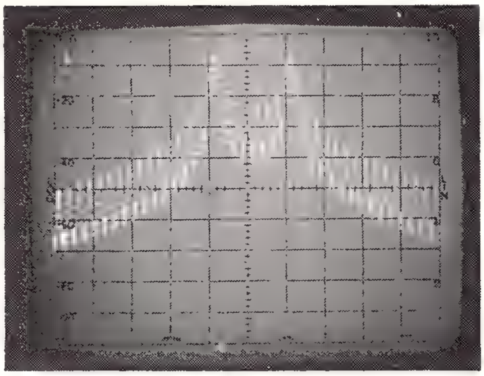

Figure 4. Frequency spectrum of a carrier frequency-modulated by a square wave of 25 Hz at a deviation of 100 Hz.

5

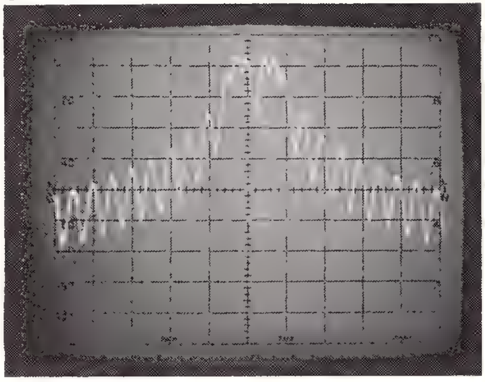

Figure 5. Frequency spectrum of a carrier frequency-modulated by a square wave of 50 Hz at a deviation of 50 hz.

6

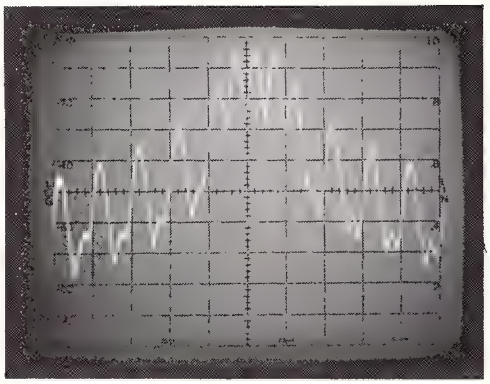

Figure 6. Frequency spectrum of a carrier frequency-modulated by a square wave of 100 Hz at a deviation of 50 Hz.

An RTTY demodulator (normally called a TU – terminal unit) continues to function satisfactorily even if one of the carriers, each of which contains the same information, disappears, due to fading, for instance. The block diagram of a typical TU for FM operation is shown in figure 8. The signal is

7

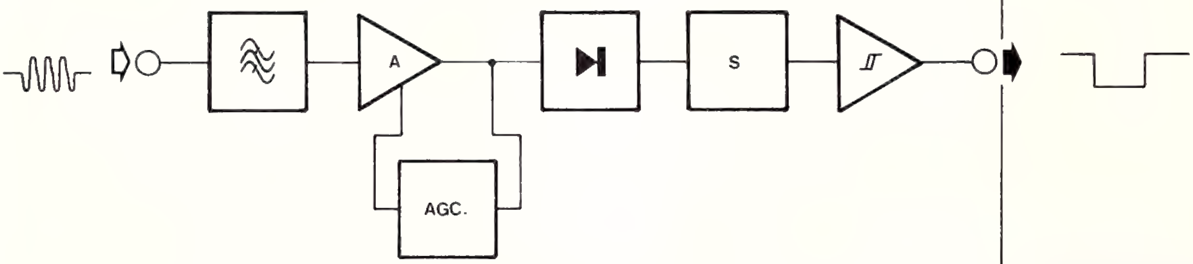

Figure 7. Block schematic diagram of a typical morse telegraphy demodulator.

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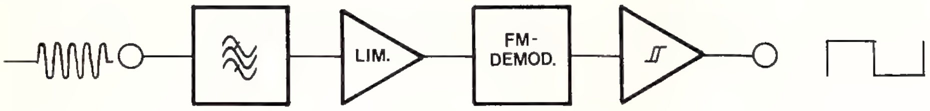

Figure 8. Block schematic diagram of a typical FSK demodulator for FM operation.

9

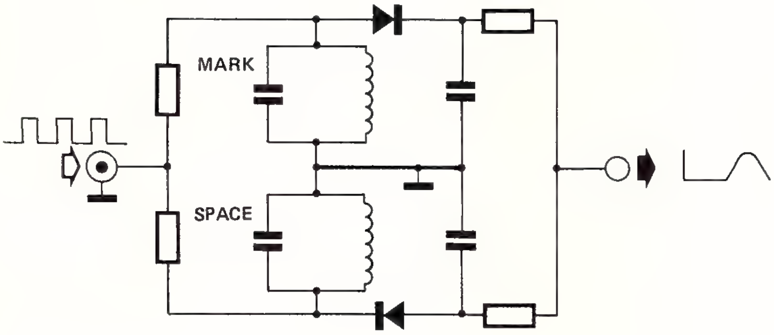

Figure 9. Circuit diagram of a frequency modulation discriminator often encountered in terminal units.

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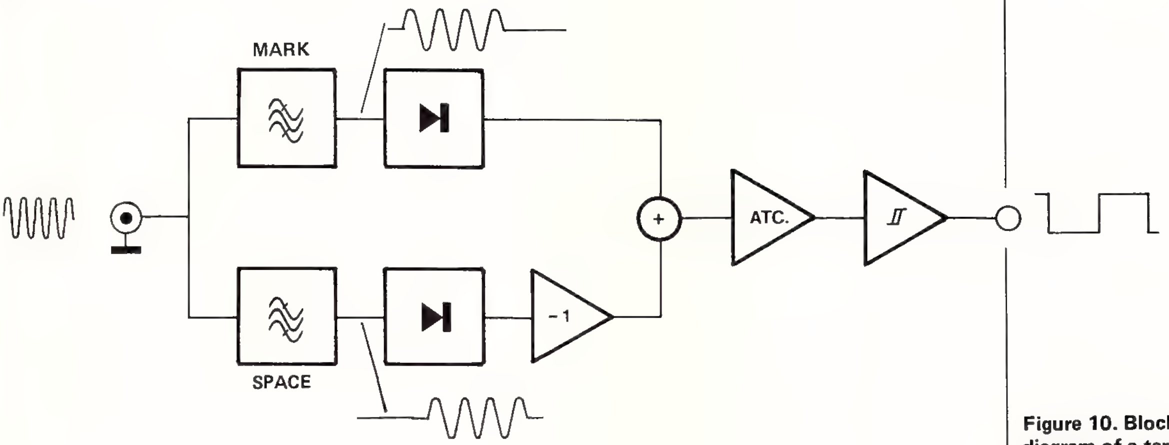


Figure 10. Block schematic diagram of a terminal unit operating as an amplitude modulation detector.

filtered, limited and then applied to a discriminator which is often of the 'true FM' type as shown in figure 9. A PLL would not be suitable because often there is no reliable relationship between marks and spaces, and the loop would then, of course, frequently be out of lock. A PLL is really only suitable if there is a guarantee that it will not get out of lock, for instance, when the frequency shift is small (85 Hz and 170 Hz are frequently used values on HF) or if operation is on VHF (30 . . . 220 MHz) where propagation is predictable.

The block schematic diagram of a TU operating as an AM detector is shown in figure 10. Separate filters are used for marks and spaces and are followed by the detectors proper. The outputs of the detectors are complementary, because when a mark is present, spaces are absent, and vice versa (see figure 11). If one of the signals disappears temporarily, the output of the adder circuit will be only half the normal value. This is, however, sufficient to drive the automatic threshold corrector (ATC) which restores the input to the trigger circuit to its correct value. The temporary absence of a mark or space is therefore unnoticeable at the trigger output. As the ATC is such a simple but effective circuit (a couple of diodes, resistors and capacitors) there are few terminal units in use today without one.

11

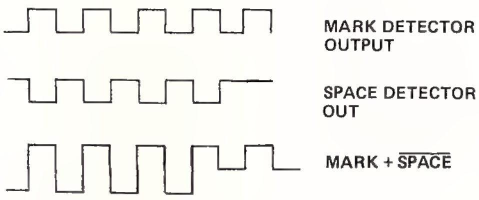


Figure 11. Idealised marks, spaces and combinations of them.

Influence of the code on transmission

A code is nothing more than an agreement to process information in a certain way before conveying such information. Language is therefore a sort of code for the exchange of ideas and feelings. An important aspect of any code is redundancy. The simplest way of ensuring redundancy is repetition. This can, however, only be used if it is possible to detect whether an error has occurred. The international morse-code characters are given in figure 12, while figure 14 shows the 5-unit Baudot and the 7-unit Moore codes. Proficient operators can often detect, and rectify, errors in the received morse-coded signals, but this is not possible with the Baudot code.

The Baudot code is the first developed RTTY code; it is an asynchronous code which means that the receiver is not synchronized with the transmitter by means of a clock. To make synchronization possible, the transmitter sends an additional, clock-controlled unit which is used to control the receiver clock. The onset of a character is indicated by a start unit which is of the same duration as a data unit. The start unit is always logic 0 and therefore corresponds to a space. The start unit is followed by the 5 data units. As the receiver and transmitter may not have kept in perfect unison, they must be re-synchronized after the last data unit: this is done by means of a stop unit. Older RTTY equipment worked at much lower speeds than their modern electronic counterpart and it was therefore perfectly acceptable to make the stop unit equal to 1.5 data unit. In modern equipment this has been brought down to 1 unit, so that all units (data, start, stop) are now of equal duration. This makes for much better synchronization of the clocks and therefore reduces the error rate. There are now a large number of RTTY stations which transmit Baudot-coded signals with only one stop unit. Asynchronous operation in which all units are of the same duration is called isosynchronous.

The baud rate is the inverse of the unit duration. For a (frequently used) baud rate of 50, the data and start units are then 20 ms and the stop units 20 or 30 ms. The baud rate itself does not give any indication of the speed with which the data are being sent. Of the 7.5 units used in Baudot (see figure 13), only five carry data and the data/unit rate is therefore (5 ÷ 7.5) x 50 = 33 units per second.

As the possibility of an error increases with every unit, this explains why in HF traffic the Baudot code is preferred over the ARQ Moore code or ASCII (American Standard Code for Information Interchange; an 8-unit standard code for the exchange of data between machines).

One source of errors in the Baudot code lies in the so-called shift function, which is analogous to the typewriter shift from lower to upper case. The maximum number of characters attainable with 5 units is 32, which is not sufficient to cope with all the letters of the alphabet, numerals and punctuation marks. The shift function is therefore used to indicate when numerals and punctuation marks are coming in; when letters are coming in again, the shift has to be reset. The troubles encountered with this method are such that press agencies process all text in letters only: five for '5',

12

A	·—
B	—···
C	—·—·
D	—··
E	·
F	··—·
G	——·
H	····
I	··
J	·———
K	—·—
L	·—··
M	——
N	—·
O	———
P	·——·
Q	——·—
R	·—·
S	···
T	—
U	··—
V	···—
W	·——
X	—··—
Y	—·——
Z	——··

Ä (German)	·—·—
Á or Å (Spanish-Scandinavian)	·——·—
CH (German-Spanish)	————
É (French)	··—··
Ñ (Spanish)	——·——
Ö (German)	———·
Ü (German)	··——

1	·————
2	··———
3	···——
4	····—
5	·····
6	—····
7	——···
8	———··
9	————·
0	—————

Period	.	·—·—·—
Comma	,	——··——
Colon	:	———···
Question mark, or request for repetition of a transmission not understood	?	··——··
Apostrophe	'	·————·
Dash or hyphen	–	—····—
Fraction bar	/	—··—·
Parenthesis (before and after words)	( )	—·——·—
Quotation marks (before and after words)	"	·—··—·
Equal sign	=	—···—
Understood		···—·
Error		········
Cross or end-of-telegram or end-of-transmission signal		·—·—·
Invitation to transmit		—·—
Wait		·—···
End of work		···—·—
Starting signal (beginning every transmission)		—·—·—

Figure 12. The International Morse code.

13

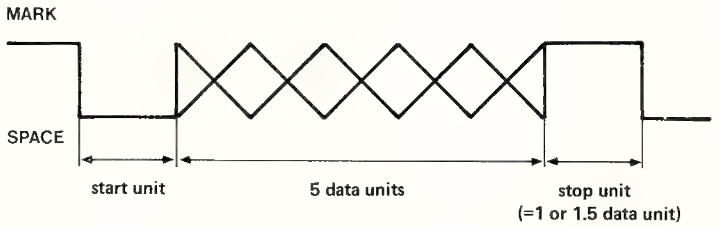


Figure 13. The composition of a Baudot character consisting of a start unit, five data units and a stop unit.

hyphen for '–', and so on. Where the alphabet in use is more extensive than our Latin-based one, these problems are even more pronounced.

A large improvement is the ARQ (Automatic ReQuest) 7-unit Moore code given in figure 14 which makes possible error detection (and eventual correction). This code which is fully synchronous (no start and stop units) gives 128 possible characters. If only those combinations are considered which give a ratio of four marks to three spaces, or vice versa, 35 characters remain available, which means that the shift function is still required. It is now, however, possible to test whether the ratio of marks to spaces is 3:4 and, if not, corrective action can be taken. In the case of one transmitter and one receiver, the transmitter is asked to repeat the part of the message where the ratio was found wanting. In the case of one transmitter and many receivers, the message is normally repeated after a certain period of time so that the original message can be compared with the repeat.

These forms of RTTY are used more and more frequently. The system where a repeat is requested is more reliable than morse operation, and it is fully automatic. The only indication of poor reception is when the buffer capacity of the receiver is exceeded. This system is gradually replacing morse communication. The system whereby message are automatically repeated after an interval of time is slowly but surely taking over from Baudot-coded traffic.

14

5-Unit Baudot Code					LETTERS	FIGURES							ARQ 7-Unit Moore Code						
1	2	3	4	5		International	W.U.	Military	TWX	Weather			1	2	3	4	5	6	7
O	O	–	–	–	A	–	–	–	–	↑			–	–	O	O	–	O	–
O	–	–	O	O	B	?	?	?	⅝	⊕			–	–	O	O	–	–	O
–	O	O	O	–	C	:	:	:	⅛	○			O	–	–	O	O	–	–
O	–	–	O	–	D	Idf.	$	$	$	↗			–	–	O	O	O	–	–
O	–	–	–	–	E	3	3	3	3	3			–	O	O	O	–	–	–
O	–	O	O	–	F	Opt.		!	¼	→			–	–	O	–	–	O	O
–	O	–	O	O	G	Opt.	&	&	&	↘			O	O	–	–	–	–	O
–	–	O	–	O	H	Opt.	#	Stop	Stop	↓			O	–	O	–	–	O	–
–	O	O	–	–	I	8	8	8	8	8			O	O	O	–	–	–	–
O	O	–	O	–	J	Bell	Bell	'	,	↙			–	O	–	–	–	O	O
O	O	O	O	–	K	(	(	(	½	←			–	–	–	O	–	O	O
–	O	–	–	O	L	)	)	)	¾	↖			O	O	–	–	–	O	–
–	–	O	O	O	M	.	.	.	.	.			O	–	O	–	–	–	O
–	–	O	O	–	N	,	,	,	⅞	⦶			O	–	O	–	O	–	–
–	–	–	O	O	O	9	9	9	9	9			O	–	–	–	O	O	–
–	O	O	–	O	P	0	0	0	0	0			O	–	–	O	–	O	–
O	O	O	–	O	Q	1	1	1	1	1			–	–	–	O	O	–	O
–	O	–	O	–	R	4	4	4	4	4			O	O	–	–	O	–	–
O	–	O	–	–	S	'	'	Bell	Bell	Bell			–	O	–	O	–	O	–
–	–	–	–	O	T	5	5	5	5	5			O	–	–	–	O	–	O
O	O	O	–	–	U	7	7	7	7	7			–	O	O	–	–	O	–
–	O	O	O	O	V	=	;	;	⅜	Φ			O	–	–	O	–	–	O
O	O	–	–	O	W	2	2	2	2	2			–	O	–	–	O	–	O
O	–	O	O	O	X	/	/	/	/	/			–	–	O	–	O	O	–
O	–	O	–	O	Y	6	6	6	6	6			–	–	O	–	O	–	O
O	–	–	–	O	Z	+	"	"	"	+			–	O	O	–	–	–	O
–	–	–	O	–	Carriage Return								O	–	–	–	–	O	O
–	O	–	–	–	Line Feed								O	–	O	O	–	–	–
O	O	O	O	O	Letters								–	–	–	O	O	O	–
O	O	–	O	O	Figures								–	O	–	–	O	O	–
–	–	O	–	–	Word Space								O	O	–	O	–	–	–
–	–	–	–	–	Blank								–	–	–	–	O	O	O
					——— RQ Signal								–	O	O	–	O	–	–
					——— Idle Alpha								–	O	–	O	–	–	O
					——— Idle Beta								–	O	–	O	O	–	–

Opt. = Optional

Idf. = Identification / Answer Back / Who Are You

Figure 14. Teleprinter codes and typical character assignments.

General principles of decoding

In general, the bits emanating from the demodulator are far from perfect. The deficiencies are caused by: (a) the pulse duration does not correspond to the reference time because the transmission rate has changed, and (b) spurious signals have distorted the data. The decoding algorithm must be capable of 'ignoring' these shortcomings, which is particularly difficult in morse decoders, because the unit duration in morse operation varies. The method used is to measure the bit duration, that is, to count it, and compare it with the reference time. If the measured time is greater than half the reference time, the bit is accepted as 1, if not, as 0. This method is used in the RTTY decoder described elsewhere in this issue, and also in the Elektor Baudot receiver program where it yields very good results. This further illustrates the importance of constant unit duration.

A further problem with Baudot traffic is that the start unit must be demodulated correctly. After switch-on, the receiver is ready for the transition from 1 to 0. As soon as this happens, the counting procedure starts. If during the counting procedure it should appear that for whatever reason the start unit has been 1 for more than half the reference time, a false start is assumed and the terminal reverts to standby. In this way, a computer will detect a false start before the start unit is finished.

In morse decoding, the microprocessor must determine and memorise the shortest bit duration at the onset of the message and then ignore, or compensate for, smaller durations. The Elektor morse decoder, as well as the RTTY decoder, have an integrator which determines the integration constant by means of an adjustable current. The setting of the current value determines the width of pulses which are to be rejected.

Synchronous systems depend on clocks for reliable operation: synchronisation is effected by means of special signals in accordance with internationally accepted regulations. The clock at both terminals is controlled by a stable, highly accurate quartz oscillator which is either thermostatically controlled or connected in a temperature-compensated circuit. Once synchronisation has been established, the two clocks are locked for a considerable time.

The decoding of RTTY signals assumes a knowledge of the baud rate: the increasing popularity of morse-telegraphy and RTTY receivers on the market is promting many stations to use non-standard baud rates. Commonly encountered rates in the HF bands are 45/50/57/100 bauds per second. ■

Mass produced digits, numbers and characters

While searching for a display for the Morse Decoder featured in the May issue, we came across an elegant display system that can be driven directly by a computer and yet uses just one IC.

The display consists of 16 characters each having 16 segments and is fluorescent — a change from the usual LED display. It is controlled by an 'Alphanumeric Display Controller' from Rockwell, the 10937. The fluorescent display and the ADC together form an ideal 16 digit display with the very minimum of components, a fact well illustrated by the circuit diagram in figure 1. In comparison, a similar circuit using discrete components would require 34 transistors and 68 resistors (or 4 . . . 8 buffer ICs). An even greater disadvantage would be the 34 I/O lines needed between the circuit and the controlling computer — a vast difference from the two (yes, just two) required with the circuit here! One line is required for Clock and the other for Data, what could be more simple? Even with the most basic host computer system (say a 6502, 6532 and 2716), digits and other characters can be displayed with the greatest of ease. Data is transferred from the host computer in serial format. It is initiated by a few control words followed by the ASCII data. Each bit must be clocked in.

In order to obtain a 'running' display, all 16 characters must be stepped along by the microprocessor. The layout of the segments of each character is shown in figure 1. As an example, the letter K is displayed when segments h, g, o, j and l are switched on. The 10937 ADC controls the 16 segments of each of the 16 characters (plus the decimal points and comma tails when needed) by means of Time Division Multiplexing (TDM). Driver stages for all of the segments are included in the IC and the only external components to be added are the pull-down resistors R1 to R34.

Data (8 bit format) at the input of the IC (pin 21) is loaded into an internal display buffer. The segment decoder then translates the contents of the buffer into the segment code for the display. Each data-byte (8 bits) starts with a control bit. If this is logic '0' the remaining seven bits correspond to the ASCII code as shown. If the control bit is logic '1' the remaining bits will be control data.

When in use, the sequence of events

1

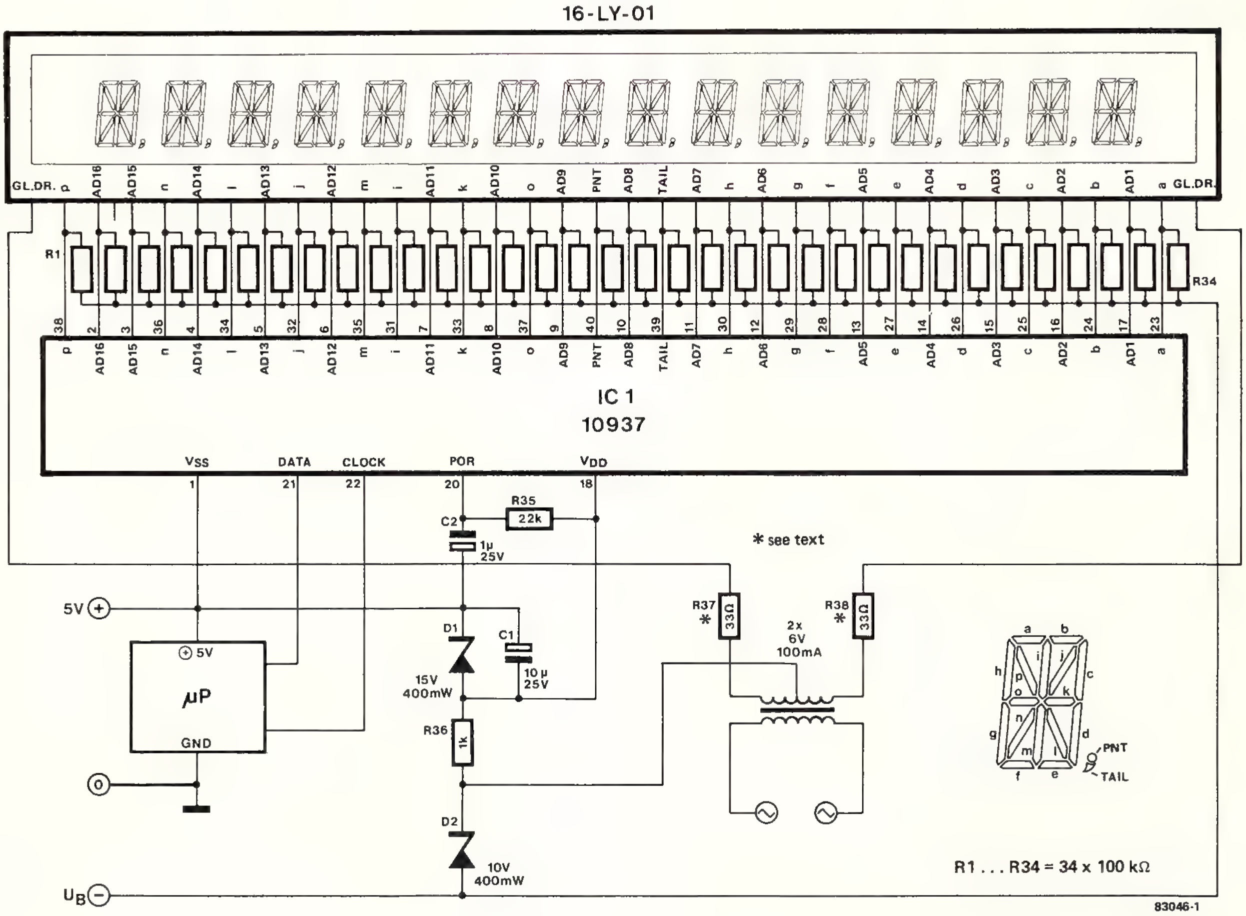


Figure 1. Only one IC is needed to control the display of 16 characters with 16 segments. The ASCII data is entered in serial format from the host computer system. There are only three interconnecting lines, the clock, data and +5 V. It is important that the computer earth is not connected to the circuit.

is as follows. Initially the IC is placed in a 'Power on Reset' condition via C2 and R35.

- The digit driver outputs AD1 . . . . AD16, all the segment driver outputs and PNT and TAIL are floating (in the off state).
- The LOAD DUTY CYCLE on time is set to 0.
- The LOAD DIGIT CNTR is set to 16.
- The LOAD BUFFER PTR is set to 15.

The data code for the first ASCII character can now be entered. Sixteen data words will fill the internal data memory (display data buffer). Before each data word is entered, the contents of the internal program counter (display buffer pointer) is automatically incremented by 1. This does not apply to the decimal point and comma. These are therefore always associated with the previous character. If a character is to be generated outside of the normal sequence and all 16 characters are in use, the control word LOAD BUFFER PTR must first be entered. This is not necessary if less than 16 character positions are in use (LOAD DIGIT CNTR is less than 0). The display data buffer is filled to the given number of character positions used (via LOAD DIGIT CNTR).

At this point it will be as well to clarify the functions of the input control data words.

- The LOAD DUTY CYCLE, as the name suggests, controls the display duty cycle. This means in effect that the displays can be varied in brightness or turned off altogether. The maximum 'on' time period for each character is 31 clock cycles. This followed by a 1 cycle (typ. 10 µs) 'inter-digit off' time to enable differentiation between two characters.
- The LOAD DIGIT COUNTER will normally only be used during the initialisation routine to define the number of character positions that are to be controlled. If the total is 16 a zero will be entered. If less than 16 enter the number desired.
- The LOAD BUFFER POINTER enables the possibility of modifying a specific character in the display. The internal DISPLAY DATA BUFFER is set to the desired character by entering the decimal value minus 2 of the character position to be modified. That means that to point to character 6 of the display a value of 4 must be entered. The situation gets even more complicated when it is necessary to point to

Display-Data	ASCII-Character	Display-Data	ASCII-Character
01000000	@	00100000	
01000001	A	00100001	!
01000010	B	00100010	"
01000011	C	00100011	#
01000100	D	00100100	$
01000101	E	00100101	%
01000110	F	00100110	&
01000111	G	00100111	'
01001000	H	00101000	(
01001001	I	00101001	)
01001010	J	00101010	*
01001011	K	00101011	+
01001100	L	00101100	,
01001101	M	00101101	—
01001110	N	00101110	.
01001111	O	00101111	/
01010000	P	00110000	0
01010001	Q	00110001	1
01010010	R	00110010	2
01010011	S	00110011	3
01010100	T	00110100	4
01010101	U	00110101	5
01010110	V	00110110	6
01010111	W	00110111	7
01011000	X	00111000	8
01011001	Y	00111001	9
01011010	Z	00111010	:
01011011	[	00111011	;
01011100	\	00111100	<
01011101	]	00111101	=
01011110	∧	00111110	>
01011111	—	00111111	?

↑ Control-Bit ↑ Control-Bit

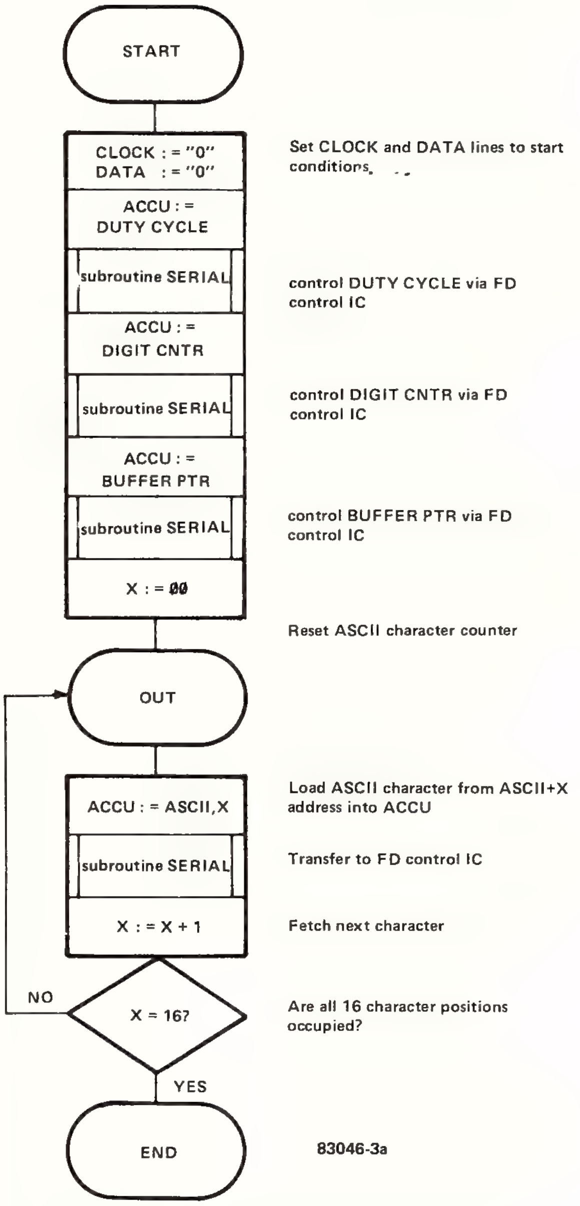
Table 1. The coding of the ASCII characters are listed here. The eigth bit determines whether the code is a control word (1) or an ASCII data word (0).

Table 2

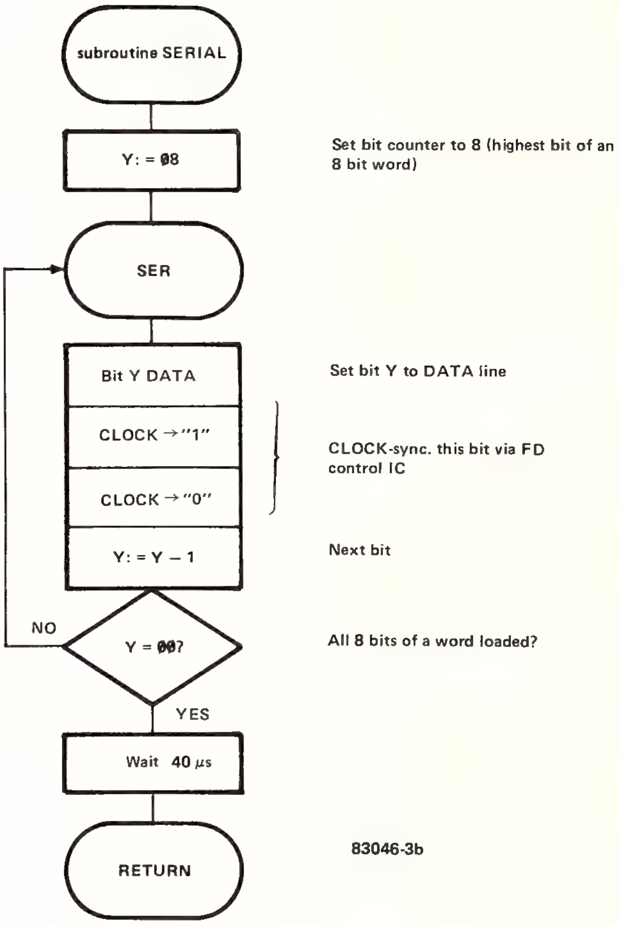
control word	code
LOAD BUFFER PTR (position of the character to be changed)	1010XXXX
LOAD DIGIT CNTR (number of digit position)	1100YYYY
LOAD DUTY CYCLE (on/off, brigthness, timing)	111ZZZZZ ↑ control bit

XXXX gives the position of the character (4 bit word)
YYYY gives the number of digit positions (4 bit word)
ZZZZZ gives the number of clock periods for which a specific digit is on (5 bit word)

Table 2. The coding of the data control words are given here.


START
CLOCK : = "0"
DATA : = "0"
Set CLOCK and DATA lines to start conditions.
ACCU : = DUTY CYCLE
subroutine SERIAL
control DUTY CYCLE via FD control IC
ACCU : = DIGIT CNTR
subroutine SERIAL
control DIGIT CNTR via FD control IC
ACCU : = BUFFER PTR
subroutine SERIAL
control BUFFER PTR via FD control IC
X : = 00
Reset ASCII character counter
OUT
ACCU : = ASCII,X
Load ASCII character from ASCII+X address into ACCU
subroutine SERIAL
Transfer to FD control IC
X : = X + 1
Fetch next character
NO
X = 16?
Are all 16 character positions occupied?
YES
END

83046-3a



83046-3b

Table 3. With the aid of this flow chart programs can be written to enable ASCII characters to be displayed.

character 1 of the display because 1 − 2 = −1! In this case, a further calculation is required: 16 (the total number of characters) minus 1 (the −1 of the previous calculation) equals 15. So, in order to point to character 1 the value 15 (hex F) must be entered.

If it is desired, when programming the ASCII characters, to deviate from the normal 'power on reset' conditions, it will be necessary to enter data in the following manner.

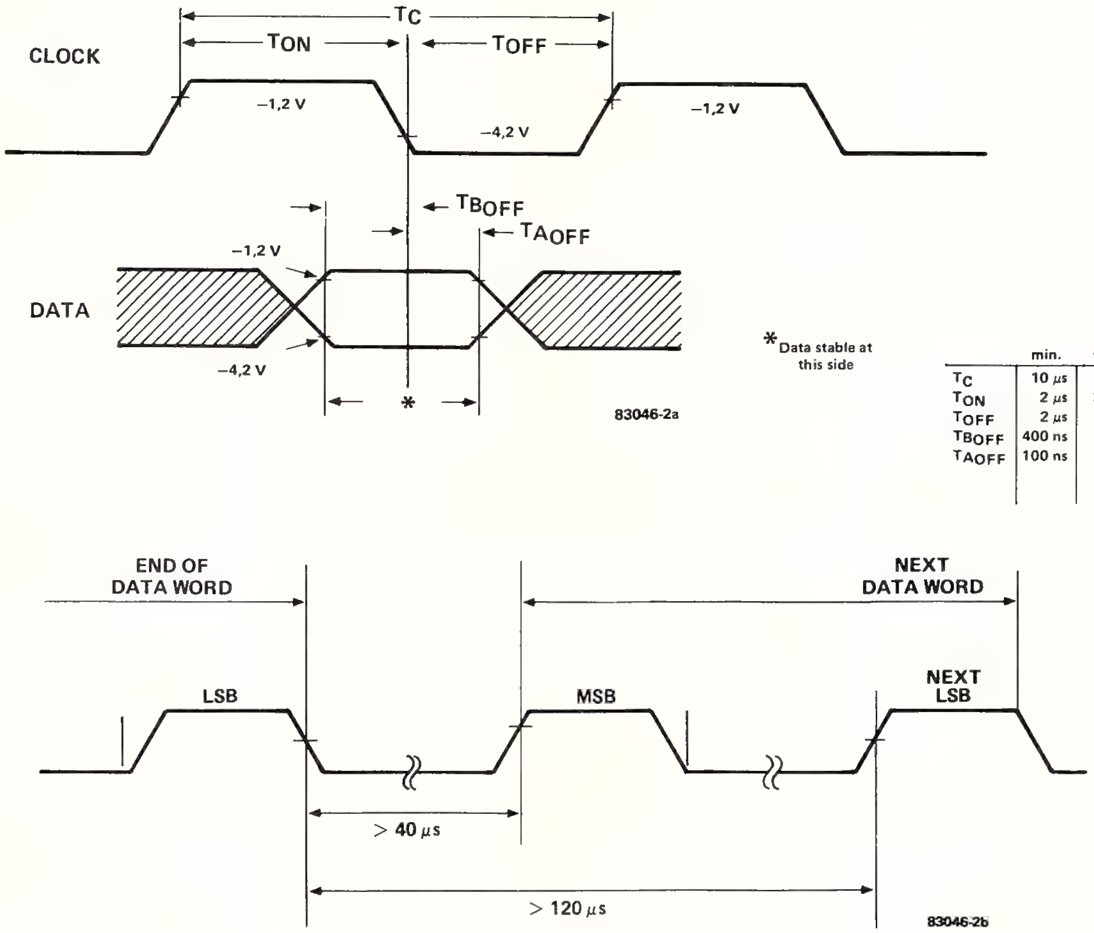
Enter LOAD DUTY CYCLE
Enter LOAD DIGIT CNTR
Enter LOAD BUFFER PTR
Enter the ASCII characters in succession.

Control words can be entered in any sequence. The order of entry is of no concern to the 10937. The coding of the control words will be found in table 2.

A word about timing. Between the end of one data word and the beginning of the next there must be a delay of at least 40 µs. The total time period for entering each data must be at least 120 µs. The timing relationship between signals at the data input and the clock is shown in figure 2.

A point to bear in mind about the hardware. Only the data, clock and +5 V lines are fed from the computer. It is important that the earth connection of the host computer is not connected to the display circuit. The values of resistors R37 and R38

2



	min.	max.
T_C	10 µs	
T_{ON}	2 µs	20 µs
T_{OFF}	2 µs	
T_{BOFF}	400 ns	
T_{AOFF}	100 ns	

Figure 2. The timing relationship between pins 21 and 22 of the 10937 are illustrated in the waveforms here.

can be found in the following manner. Before the display is wired in, a 100 Ω 1 watt resistor is connected between the two wires leading to the GL DR points of the display.. The voltage across this resistor is measured and should be about 7.2 V_{rms}. This should result in a value of 33 Ω for resistors R37 and R38 when a 2 x 6 V transformer is used. Variations in the transformer secondary voltage can be taken care of by altering the values of R37 and R38.

If desired a manual reset can be incorporated in the circuit by a push button in series with a 100 Ω resistor across capacitor C2.

To finalise, a few points of note about the software. With the aid of the flow chart in table 3, a program can be writted that will transfer the ASCII characters of table 1 onto the display. Remember that the first character entered will be at the right hand end of the display and the last entered will be at the left. Any spaces that occur (if less than 16 digits are used) will be on the left of the display.

Literature:
Rockwell data sheet — 10937 Alpha Numeric Display Controller.
Futaba 16-LY-01 display and Rockwell 10937 available from:
Regisbrook Limited, 215 Kings Road, Reading RG1 4LS.
Telephone 0734 665955.

IC1	driver-voltage	U_B
10937P-20	20 V	−15 V
10937P-30	30 V	−25 V
10937P-35	35 V	−30 V
10937P-40	40 V	−35 V

Input voltage

(relative to +5 V)

	min.	max.
"1"	+0,3 V	−1,2 V
"0"	−4,2 V	U_B

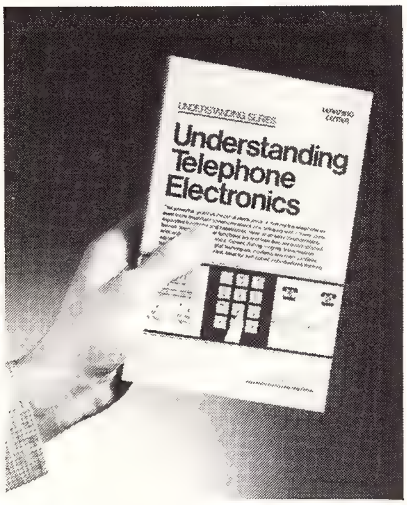
Current consumption: 40 mA max.

Table 4. Supply voltages and the logic levels for the variations of the 10937 IC. These are measured with respect to the +5 V provided by the host computer.

market

Understand telephones

Telephone communication, a century old, is now — with digitisation — moving into its second major phase of development. Helping engineers and others to understand the latest changes is a new book published by Texas Instruments. It is the twelfth title in TI's 'Understanding . . .' series.



'Understanding Telephone Electronics' follows the series' practice by taking the reader step by step from the simplest explanation of telephonic principles through to an intermediate level of telecomms learning. The book covers the technologies incorporated in dialling, ringing, transmission, signalling, switching, digital techniques, modems and cordless telephones. At the end of each chapter is a summary quiz, making the book ideal for self-paced individual learning. It is available at £3.95 per copy (plus £1.50 per order to cover p+p).

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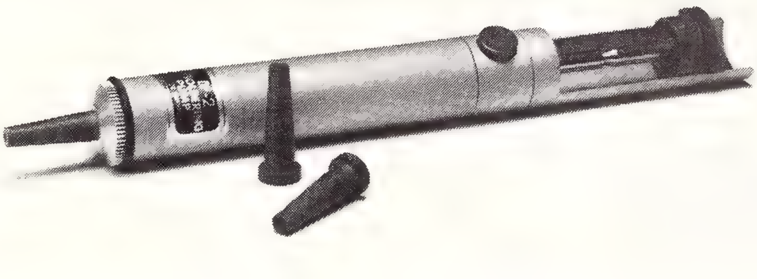
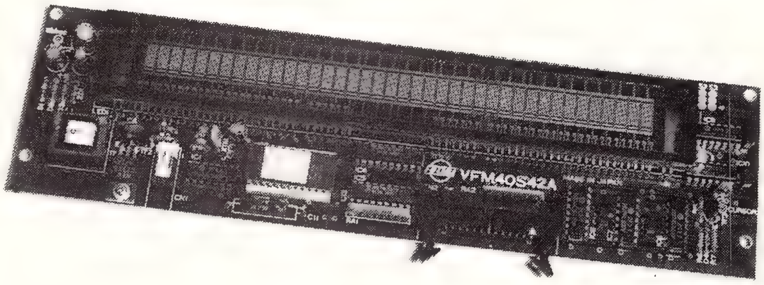


Visual display modules

Regisbrook Ltd. have announced a new range of products from their exclusive Futaba franchise. They are visual display modules — a single board package of vacuum fluorescent display, driver and power supply.

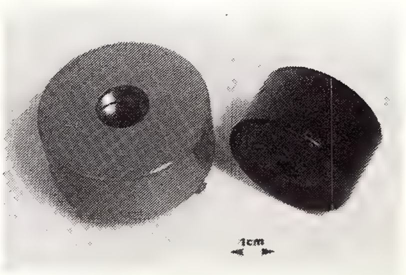
An example from the range is the VFM 40-S02A vacuum fluorescent module. This provides a 40 character alphanumeric display — each character being a 5 x 7 dot matrix, 5 mm high, with an average brightness of 180 foot/lamberts. Also on the single board is a Rockwell intelligent controller and a Mitsubishi microprocessor. The module requires a single 5 volt power supply and offers a serial or parallel interface.



Regisbrook Limited,
Studio House,
215 Kings Road,
Reading RG1 4LS,
Berkshire.
Telephone: 0734 665955 (2693 M)

Acoustic resonators

The PKM29-3AO piezo-acoustic transducer can justifiably claim to be nuisance, delivering over 85 dBA at 3 metres, at a frequency of 3.4 kHz. In fact, we defy anyone reading this with 'normal' hearing to remain in an 'average' room of 200 cubic metres volume with one of these compact transducers sounding an alarm.



The PKM29-3AO is designed for external excitation (9 V p-p at 15 mA to deliver that rated output mentioned above).

The smaller of the two resonators shown in the photograph, the PKB8-4AO is a self-excited sounder, resonant at 2.7 kHz: which is close to the ear's fundamental resonance, and at the peak of perceived 'loudness'. The unit can be powered from 3 to 20 V, and delivers more than 75 dB at a distance of 1 metre. To put this in context, it would be difficult to hold a conversation within approximately 10 feet of the alerter, when powered from a 9 V source.

Ambit International,
200 North Service Road,
Brentwood,
Essex CM14, 4SG.

(2695 M)

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next month...

Our Bumper July/August issue

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The long awaited implementation of on-line order processing is with us at last, and whilst this means that orders for in-stock items can now be processed more efficiently, it also means that orders should be submitted using stock codes for best results. Our current catalogue (75p) includes all order codes (watch out for the new expanded Spring edition), but here's an abstract from some of the more popular lines to use as a quick reference.

Remember that you can also access our catalogue via REWSHOP on REWTEL, which now includes on-line current price and delivery information. You need a 300 baud MODEM and RS232 terminal, (various suitable configurations based on popular micros have been published in recent past issues of Radio and Electronics World).

Prices shown here exclude VAT, and the P&P charge is currently 60p per order (unless otherwise indicated). Remember that our telesales service operates with human beings (not 'dumb' machines) from 8am to 7pm (and frequently later) Monday to Friday, and 9am to 6pm on Saturdays. REWSHOP operates 24 hours a day, 365 days a year with full price and delivery information.

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4011	23-04011	0.11
4011UB	23-04011	0.11
4012	23-04012	0.14
4013	23-04013	0.25
4015	23-04015	0.50
4016	23-04016	0.22
4017	23-04017	0.40
4020	23-04020	0.55
4021	23 04021	0.55
4022	23-04022	0.55
4023	23-04023	0.15
4024	23 04024	0.33
4025	23 04025	0.15
4027	23-04027	0.26
4028	23 04028	0.50
4029	23 04029	0.55
4035	23-04035	0.67
4040	23-04040	0.68
4042	23-04042	0.50
4043	23 04043	0.60
4044	23 04044	0.68
4046	23-04046	0.60
4049UB	22-04049	0.24
4050	23 04050	0.24
4051	23 04051	0.55
4052	23-04052	0.55
4053	23-04053	0.55
4060	23-04060	0.75
4066	23-04066	0.30
4068	23 04068	0.16
4069UB	22-04069	0.14
4070	23-04070	0.16
4071	23-04071	0.16
4072	23-04072	0.16
4073	23-04073	0.16
4075	23-04075	0.16
4076	23-04076	0.55
4077	23 04077	0.18
4078	23-04078	0.18
4081	23-04081	0.18
4082	23 04082	0.18
4093	23 04093	0.30
4099	23 04099	0.80
4175	23-04175	0.80
4502	23-04502	0.60
4503	23-04503	0.50
4506	23-04506	0.70
4507	23-04507	0.37
4508	23-04508	1.50
4510	23-04510	0.55
4511	23-04511	0.45
4512	23-04512	0.55
4514	23-04514	1.25
4515	23-04515	1.25
4516	23-04516	0.60
4518	23-04518	0.35
4520	23-04520	0.60
4521	23-04521	1.30
4522	23-04522	0.89
4526	23 04526	0.60
4527	23-04527	0.80
4528	23-04528	0.65
4529	23-04529	0.70
4531	23-04531	0.65
4532	23-04532	0.80
4534	23-04534	4.00
4536	23-04536	2.50
4538	23-04538	0.85
4539	23-04539	0.80
4543	23-04543	0.80
4549	23-04549	3.50
4553	23-04553	2.70
4554	23-04554	1.20
4555	23-04555	0.35
4556	23-04556	0.40
4557	23-04557	2.30
4558	23-04558	0.80
4559	23-04559	3.50
4560	23-04560	2.50
4561	23-04561	1.00
4562	23-04562	2.50
4566	23-04566	1.20
4568	23-04568	1.45
4569	23-04569	1.70
45672UB	23-04572	0.32
4580	23-04580	3.25
4581	23-04581	1.40
4582	23-04582	0.70
4583	23-04583	0.80
4584	23-04584	0.27
4585	23-04585	0.45
4702	23-04702	4.50
4703	23-04703	4.46
4704	23-04704	4.24
4705	23-04705	4.24
4706	23-04706	4.50
4720	23-04720	4.00
4723	23-04723	0.95
4724	23-04724	0.95
4725	23-04725	2.24
40014	23-40014	0.54
40085	23-40085	0.89
40098	23-40098	0.54
40106	23-40106	0.69
40160	23-40160	1.05
40161	23-40161	1.05
40162	23-40162	1.05
40163	23-40163	1.05
40174	23-40174	1.05
40175	23-40175	1.05
40192	23-40192	1.08
40193	23-40193	1.08
40195	23-40195	1.08

74LSXX

Type	Stock No.	Price
74LS00	31 07400	0.11
74LS01	31 07401	0.11
74LS02	31 07402	0.11
74LS03	31-07403	0.11
74LS04	31-07404	0.14
74LS05	31-07405	0.14
74LS08	31-07408	0.14
74LS09	31-07409	0.14
74LS10	31-07410	0.14
74LS11	31-07411	0.14
74LS12	31-07412	0.14
74LS13	31 07413	0.32
74LS14	31-07414	0.32
74LS15	31-07415	0.14
74LS20	31-07420	0.14
74LS21	31-07421	0.14
74LS22	31-07422	0.14
74LS26	31-07426	0.14
74LS27	31 07427	0.30
74LS28	31-07428	0.18
74LS30	31-07430	0.14
74LS32	31 07432	0.14
74LS33	31 07433	0.14
74LS37	31-07437	0.18
74LS38	31-07438	0.14
74LS40	31 07440	0.18
74LS42	31-07427	0.30
74LS47	31-07447	0.75
74LS48	31-07448	0.40
74LS49	31-07449	0.80
74LS51	31-07451	0.14
74LS54	31-07454	0.14
74LS55	31 07455	0.14
74LS74	31-07474	0.21
74LS75	31-07475	0.21
74LS76	31-07476	0.25
74LS78	31-07478	0.19
74LS83	31-07483	0.33
74LS85	31 07485	0.44
74LS86	31 07486	0.15
74LS90	31 07490	0.24
74LS91	31-07491	0.36
74LS92	31 07492	0.32
74LS93	31-07493	0.24
74LS95	31-07495	0.36
74LS107	31-74107	0.31
74LS109	31-74109	0.25
74LS112	31 74112	0.21
74LS113	31-74113	0.21
74LS114	31-74114	0.21
74LS122	31-74122	0.27
74LS123	31 74123	0.36
74LS125	31-74125	0.27
74LS126	31 74126	0.27
74LS132	31-74132	0.27
74LS133	31-74133	0.24
74LS136	31-74136	0.20
74LS138	31-74138	0.30
74LS139	31 74139	0.30
74LS151	31 74151	0.30
74LS153	31-74153	0.34
74LS155	31 74155	0.30
74LS156	31 74156	0.33
74LS157	31-74157	0.27
74LS158	31-74158	0.27
74LS160	31-74160	0.34
74LS161	31-74161	0.36
74LS162	31-74162	0.36
74LS163	31-74163	0.36
74LS164	31-74164	0.40
74LS165	31-74165	0.80
74LS166	31-74166	0.58
74LS168	31-74168	0.89
74LS170	31-74170	0.83
74LS173	31-74173	0.47
74LS174	31-74174	0.37
74LS175	31 74175	0.40
74LS181	31-74181	0.87
74LS183	31-74183	1.05
74LS190	31-74190	0.39
74LS191	31-74191	0.39
74LS192	31-74192	0.39
74LS193	31-74193	0.39
74LS194	31 74194	0.39
74LS195	31 74196	0.39
74LS196	31-74196	0.39
74LS197	31 74197	0.47
74LS221	31-74221	0.50
74LS240	31 74240	0.60
74LS241	31-74241	0.60
74LS242	31 74242	0.55
74LS243	31 74243	0.55
74LS244	31 74244	0.60
74LS245	31 74245	1.00
74LS251	31 74251	0.36
74LS253	31-74253	0.36
74LS257	31 74257	0.36
74LS258	31 74258	0.36
74LS259	31-74259	0.51
74LS260	31 74260	0.26
74LS266	31 74266	0.20
74LS273	31 74273	0.70
74LS279	31-74279	0.35
74LS283	31 74283	0.40
74LS290	31-74290	0.40
74LS293	31-74293	0.40
74LS298	31-74298	0.54
74LS365	31-74365	0.34
74LS366	31-74366	0.40
74LS367	31-74367	0.30
74LS368	31-74368	0.30
74LS373	31-74373	0.72
74LS374	31-74374	0.72
74LS375	31 74375	0.31
74LS377	31 74377	0.60
74LS378	31-74378	0.44
74LS379	31-74379	0.44
74LS385	31-74385	1.30
74LS386	31-74386	0.27
74LS390	31 74390	0.51
74LS393	31-74393	0.48
74LS398	31 74398	0.80
74LS399	31 74399	0.65
74LS490	31-74490	0.60
74LS670	31-74670	1.15

74CXX

Type	Stock No.	Price
74C00	29-07400	0.35
74C02	29 07402	0.35
74C04	4069C	
74C08	29-07408	0.35
74C10	29-07410	0.35
74C14	4584C	
74C20	29-07420	0.35
74C30	29-07430	0.35
74C32	29-07432	0.35
74C42	29-07442	1.05
74C48	29-07448	1.50
74C73	29-07473	0.75
74C74	29-07474	0.75
74C76	29-07476	0.60
74C83	29-07483	1.30
74C85	29-07485	1.30
74C86	29-07485	1.30
74C89	29-07489	3.60
74C90	29-07490	1.05
74C93	29-07493	1.05
74C95	29-07495	1.25
74C107	29-74107	0.60
74C151	29-74151	2.10
74C154	29 74154	3.05
74C157	29 74157	2.10
74C160	40160	
74C1610	40161CM	
74C1620	40162CM	
74C1630	40163CM	
74C164	29-74164	1.05
74C165	29-74165	1.10
74C173	4076C	
74C1740	40174CM	
74C1750	40175CM	
74C1920	40192CM	
74C1930	40193CM	
74C1950	40195CM	
74C200	29-74200	6.60
74C221	29 74221	1.55
74C901	29-74901	0.55
74C902	29 74902	0.55
74C903	29-74903	0.55
74C904	29-74904	0.55
74C905	29-74905	6.50
74C906	29-74906	0.55
74C907	29-74907	0.55
74C908	29-74908	1.10
74C909	29-74909	2.10
74C910	29-74910	5.00
74C914	29-74914	1.10
74C918	29-74918	1.30
74C925	29-74925	6.00
74C926	29-74926	6.00
74C927	29-74927	6.00

74HCXX

Type	Stock No.	Price
74HC00	30-07400	0.56
74HC02	30-07402	0.56
74HC04	30-07404	0.68
74HC10	30-07410	0.56
74HC20	30-07420	0.56
74HC86	30 07486	0.74
74HC132	30-74132	1.26
74HC266	30 74266	0.81
74HC4002	30-04002	0.56
74HC4075	30-04075	0.56
74HC242	30 74242	2.00
74HC243	30-74243	2.00
74HC74	30-07474	0.74
74HC109	30-74109	0.68
74HC175	30 74175	1.08
74HC373	30 74373	2.40
74HC374	30 74374	2.40
74HC533	30 74533	2.40
74HC534	30-74534	2.40
74HC165	30 74165	1.96
74HC173	30-74173	1.20
74HC160	30 74160	1.33
74HC161	30 74161	1.33
74HC162	30 74162	1.33
74HC163	30-74163	1.33
74HC4538	30-74538	2.10
74HC85	30-74280	2.95
74HC280	30 74280	2.95
74HC42	30-07442	1.00
74HC138	30 74138	1.08
74HC139	30 74139	1.08
74HC4514	30-04514	3.40
74HC4543	30-04543	2.75
74HC157	30 74157	0.92
74HC158	30 74158	0.90
74HC257	30-74257	0.90

LINEAR ICs

Type	Stock No.	Price
LM10CN	61-00010	3.88
MF10	61-00011	5.05
L149	61 00149	1.86
ZNA234	61 02340	8.50
U237B	61-00237	1.28
U247B	61-00247	1.28
U257B	61-00257	1.28
U267B	61-00267	1.28
LM301AH	61-03010	0.67
LM301AN	61-03011	0.27
LM308H	61-03080	0.70
LM308CN	61-03081	0.65
LM324	61 03240	0.45
LM339N	61-03390	0.66
LF347	61-00347	1.80
LM348	61-03480	0.90
LF351	61-03510	0.49
LF353	61-03530	0.76
LM380N	61-00380	1.00
LM381	61-00381	1.81
LM382	61-00382	1.81
ZN419CE	61-00419	1.98
ZNA423	61-04230	1.00
ZN425E/8	61-04250	3.50
ZN426E/8	61-04260	3.00
ZN427E/8	61 04270	6.28
ZN428E/8	61-04280	4.78
ZN429E/8	61-04290	2.10
ZN432CJ10	61-04320	28.09
ZN433CJ10	61-04330	22.59
ZN450E	61-04500	7.61
NE542	61-05420	1.20
NE544	61-00544	1.80
NE555N	61-05550	0.20
NE556N	61-05560	0.50
SL560C	61-05600	1.98
NE562	61-00562	4.05
NE564	61 00564	4.29
NE565	61-00565	1.00
NE566	61-00566	1.30
NE567	61-00567	1.30
NE570N	61-00570	3.85
SL624	61-00624	3.28
uA709HC	61-07090	0.64
uA709PC	61-07091	0.36
uA710HC	61-07100	0.64
uA710PC	61-07101	0.59
uA711CN	61-07110	0.85
uA733CN	61-07330	0.89
uA741CH	61-07410	0.66
uA741CN	61-07411	0.20
uA747CN	61-07470	0.70
uA748CN	61-04780	0.30
uA758	61-00758	2.35
TBA820M	61-00820	0.78
TDA1028	61-01028	2.11
TDA1029	61-01029	2.11
ZNA1034	61-01034	2.10
LM1035	61-01034	2.10
TDA1054M	61 01054	1.45
TDA1062	61-01062	1.95
TDA1072	61-01072	2.69
TDA1074A	61-01074	5.04
TDA1083	61-01083	1.95
TDA1090	61-01090	3.05
HA1137	61 12411	1.20
HA1196	61-01196	2.00
HA1197	61-01197	1.00
TDA1220	61-01220	1.40
LM1303	61-01303	0.99
LM1307	61-01307	1.55
MC1310P	61-01310	1.90
MC1330	61-01330	1.20
MC1350	61-01350	1.20
HA1370	61-11370	1.90
HA1388	61-01388	2.75
LM1458N	61 14580	0.45
MC1496P	61-01496	1.25
SL1610	61-01610	1.92
SL1611	61-01611	1.92
SL1612	61-01612	1.92
SL1613	61-01613	2.06
SL1620	61-01620	2.50
SL1621	61-01621	2.50
SL1623	61-01623	2.50
SL1625	61-01625	2.50
SL1626	(SL6270)	
SL1630	61-01630	1.62
SL1640	61-01640	2.25
SL1641	61-01641	2.25
MC1648	61-01648	3.25
TDA2002	61-02002	1.25
ULN2240	61-02240	3.25
ULN2242	61-01090	3.05
ULN2283	61 02283	1.00
CA3080	61-03080	0.70
CA3089	61-03089	1.84
CA3123	61-03123	1.40
CA3130E	61 31300	0.80
CA3130T	61 31301	0.90
CA3140E	61-31400	0.46
CA3189E	61-03189	2.20
CA3240E	61 32400	1.27
MC3357	61-03357	2.85
MC3359 (see ULN3859)		
ULN3859	61-03859	2.95
KM3701	61-03701	85.53
KM3702	61-03702	74.84
LM3900	61 39000	0.60
LM3909N	61 39090	0.68
LM3914N	61-03914	2.80
LM3915N	61 03915	2.80
KB4400	61-04400	0.80
KB4412	61-04412	1.95
KB4413	61-04413	1.95
KB4417	61-04417	1.80
KB4420B	61-04420	1.09
TDA4420	61-14420	2.65
TDA4421	61-14421	2.65
KB4423	61-04423	2.30
KB4424	61 04424	1.65
KB4430	61 04430	2.30
KB4431	61-04431	1.95
KB4432	61-04432	1.95
KB4433	61-04433	1.52
KB4436	61-04436	2.53
KB4437	61 04437	1.75
KB4438	61-04438	2.22
KB4441	61 04441	1.35
KB4445	61-04445	1.29
KB4446	61 04446	2.75
KB4448	61 04448	1.65
NE5044	61 05044	2.26
MC5229	61 05229	9.60
NE5532	61 55320	1.85
KM5624	61-05624	4.35
SD6000	61 06000	3.75
SL6270	61 06270	2.03
SL6310	61-06310	2.45
SL6440	61-06440	3.38
SL6600	61-06600	3.75
SAS6610	61-06610	1.48
SL6640	61-06640	2.75
SL6690	61-06690	3.75
SL6700	61-06700	2.75
SAS6710	61-06710	1.48
LS7225	61-07225	3.85
ICM7555	61-75550	0.80
CL8038CC	61-08038	4.50
MSL9362	61-09362	1.75
MSL9363	61-093?.	1.75
K10170	61-10170	1.87
TK10321	61-10321	2.75
HA11223	61 11223	2.15
HA11225	61 11225	1.45
HA12002	61 12002	1.22
HA12017	61-12017	0.80
HA12402	61 12402	1.95
HA12411	61 12411	1.20
HA12412	61 12412	1.55
LF13741	61 13741	0.33
MK50366	61 50366	3.35
MK50375	61-50375	3.85
MM53200	61-53200	3.90

PRESCALER

Type	Stock No.	Price
U264	61-02640	2.27
U265	61 02650	3.16
U266	61 02660	2.43
11C90DC	61 01190	12.95
MSL2312R	61 02312	3.94
MSL2318	61-02318	3.84
MSM5523	61-05523	11.30
MSM5524	61-05524	11.30
MSM5525	61 05525	7.85
MSM5526	61 05526	7.85
MSM55271	61 55271	9.75
ICM7106CP	61 07106	9.55
ICM7107CP	61 07107	9.55
LC7137	61 07137	7.50
ICM7216B	61 72161	19.50
ICM7216C	61 72162	19.95
ICM7217A	61 07217	9.50
SP8629	61-08629	3.85
SP8647	61-08647	6.00
SP8793	61-08793	7.70
95H90	61-09590	7.80
HD10551	61 10551	2.45
HA12009	61 12009	6.00
HD44015	61 44015	4.45
HD44752	61-44752	8.00
MC145151P	61 14151	6.00
MC145152P	61-14151	6.60
MC145156P	61-14156	4.60

SMALL SIGNAL AUDIO

Type	Stock No.	Price
BC182	58 00182	0.10
BC212	58 00212	0.10
BC237	58-00237	0.08
BC238	58-00238	0.08
BC239	58-00239	0.08
BC307	58-00307	0.08
BC308	58-00308	0.08
BC309	58 00309	0.08
BC327	58-00327	0.13
BC337	58 00337	0.13
BC413	58 00413	0.10
BC414	58-00414	0.11
BC415	58 00415	0.10
BC416	58 00416	0.11
BC546	58 00546	0.12
BC550	58 00550	0.12
BC556	58-00556	0.12
BC560	58 00560	0.12
BC639	58-00639	0.22
BC640	58-00640	0.22
MPSA13	58-04013	0.30
MPSA63	58-04063	0.30
ZTX108	58 01108	0.10
ZTX212	58-01212	0.10
ZTX653	58 01653	0.20
ZTX753	58-01753	0.20
2N2904	58-02904	0.25
2N2905	58-02905	0.25
2N3905	58 03905	0.10
2SB646A	58-03646	0.30
2SB648A	58 03648	0.40
2SD666A	58 03666	0.30
2SD668A	58-03668	0.40
2SA872A	58-02872	0.19
2SA1084E	58-01084	0.25
2SA1085E	58-01085	0.25
2SC1775A	58-01775	0.19
2SC2546E	58-02546	0.24
2SC2547E	58-02547	0.24

AUDIO POWER

Type	Stock No.	Price
BD139	58-15139	0.29
BD140	58 15140	0.31
BD165	58-15165	0.46
BD166	58 15166	0.48
BD179	58-15179	0.38
BD180	58-15180	0.41
TIP31A	58-15031	0.35
TIP32A	58 15032	0.35
MJ2955	58-12955	0.88
2N3055	58 13099	0.58
2SB720	58 15720	0.60
2SD760	58-17600	0.60
2SJ49	60-01049	3.10
2SJ50	60-01050	4.25
2SJ83	60-01083	3.55
2SK134	60-00134	3.10
2SK135	60-00135	4.25
2SK227	60-00227	3.55
2SD753	58-03753	2.34

SMALL SIGNAL RF

Type	Stock No.	Price
BFY50	58 06500	0.22
BF241	58-06241	0.18
BF273	58-06273	0.18
BF274	58-06274	0.20
BF362	58 06362	0.49
BF440	58-06440	0.21
BF441	58 06441	0.21
BF479	58 06479	0.66
BF6795	58 06679	0.55
BFR91	58-07091	1.33
BFT95	58 10095	0.99
BFW92	58 08092	0.60
BFY90	58-09090	0.90
NE21936	58 21936	5.00
ZTX323	58-06232	0.60
2N2369A	58 02369	0.38

RF POWER

Type	Stock No.	Price
BFW16A	58 08016	0.65
MRF237	58 14237	3.20
MRF238	58 14238	16.50
MRF245	58 14245	40.00
MRF449A	58 14449	16.50
MRF472	58 14472	1.25
MRF475	58 14475	4.60
MRF629	58-14629	4.99
PT8811	58 18811	9.50
TP2320	58 12320	10.24
VN66AF	60 02066	0.95
ZTX3866	58-03866	0.45
2N3866	58 13866	1.20

SMALL SIGNAL FET

Type	Stock No.	Price
BF256	59-00256	0.38
BF960	60 06960	0.99
BF961	60-06961	0.70
BF963	60-06963	0.99
J310	59-02310	0.69
J176	59 02176	0.65
2SK55	59-01055	0.32
2SK168	59-01168	0.37
3SK45	60 04045	0.49
3SK51	60-04051	0.54
3SK60	60 04060	0.58
3SK88	60 04088	0.99
40673 see 3SK51		
40822 see 3SK51		
40823	60-03823	0.65
3SK112	60-04112	4.60

DIODES

Type	Stock No.	Price
AA112	12-01126	0.25
BA244	12-02447	0.17
BA379	12 03797	0.35
ND4981 7E	12-49817	0.51
OA91	12-00916	0.07
OA47	12-00476	0.10
PW02	12-62006	0.75
S04	12 24006	0.45
W005	12 10506	0.28
1N4001	12-40016	0.06
1N4002	12-40026	0.07
1N4004	12 40046	0.07
1N4148	12-41486	0.05
1N5404	12-54046	0.16
1N6263	12 62637	0.62

VARICAPS

Type	Stock No.	Price
BA102	12-01025	0.30
BA121	12-01215	0.30
BB105B	12-01055	0.30
BB109B	12-01095	0.27
BB204B	12 02045	0.36
BB212	12-02125	1.95
ITT210	12 02105	0.30
MVAM115 see KV1236		
MVAM125 see KV1225		
KV1210	12-12105	2.45
KV1211 see KV1236		
KV1225	12 12255	2.75
KV1235	12 12355	2.75
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4V7	12 00478	0.10
5V1	12 00518	0.10
5V6	12 00568	0.10
6V8	12-00688	0.10
8V2	12-00828	0.10
9V1	12-00918	0.10
10	12-01008	0.10
11	12-01108	0.10
12	12-01208	0.10
15	12 01508	0.10
18	12 01808	0.10
22	12 02208	0.10
27	12 02708	0.10
33	12-03308	0.10

SCRS TRIACS

Type	Stock No.	Price
BRY55 100	52 55100	0.50
C106D1	52 00106	0.70
C122D1	52 00122	1.45
2N6403	52-06403	2.22
2N6073A	58-06073	0.98

BALANCED MIXERS

Type	Stock No.	Price
SBL1	12-00003	4.68
SBL1 8	12-00013	5.00
SBL1 X	12-00023	6.33
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SRA1 1	12-00043	12.77
SRA1H	12-00053	16.34
SRA3	12-00063	15.35

LEDs

3mm round types

Type	Stock No.	Price
CQX25 Red/Clr	15 20250	0.15
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CQX26 Gr/Clr	15-20260	0.16
V179P Green	15 01790	0.16
CQX27 Yel/Clr	15 20270	0.18
V180P Yellow	15 01800	0.18
CQX41A-Or/Rd	15 20410	0.19

Standard 5mm DIA LEDs

Type	Stock No.	Price
CQY40L Red	15 10400	0.12
CQY72L Green	15 10720	0.15
CQY74L Yellow	15-10740	0.15
CQX38A Or/rd	15 20380	0.20
CQX39B Or/cl	15-20390	0.29

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Type	Stock No.	Price
CQX10 Red	15 20100	0.17
CQX11 Green	15 20110	0.20
CQX12 Yellow	15 20150	0.20
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Infra-Red LEDs

Type	Stock No.	Price
CQY99 Emit	15 10990	0.56
BPW41 Det	15 30410	1.51

I R Optocoupler

Type	Stock No.	Price
BNY37	15-40370	1.44

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Type	Stock No.	Price
V320	15-03200	0.17
V321	15-03210	0.26
V322	15-03220	0.20
V323	15-03230	0.20
V330	15-03300	0.17
V331	15-03310	0.26
V332	15-03320	0.20
V333	15-03330	0.20
V340	15-03400	0.17
V341	15-03410	0.26
V342	15-03420	0.20
V343	15-03430	0.20
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V530	15-05300	0.17
V531	15-05310	0.26
V532	15-05320	0.20
V533	15-05330	0.20
V540	15-05200	0.17
V541	15-05410	0.26
V542	15-05420	0.20
V543	15-05430	0.20
V550	15-05500	0.17
V551	15-05510	0.26
V552	15-05520	0.20
V553	15-05530	0.20

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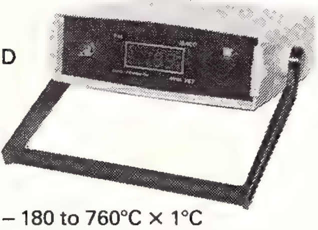

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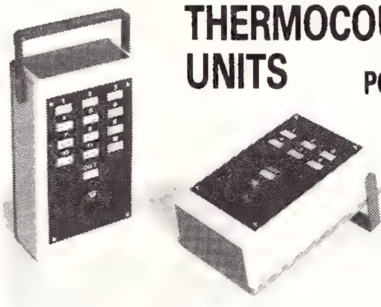

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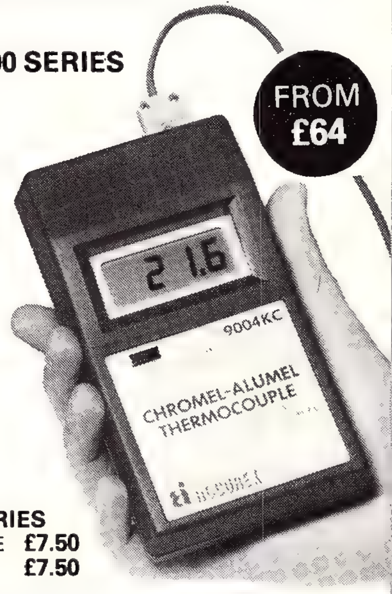

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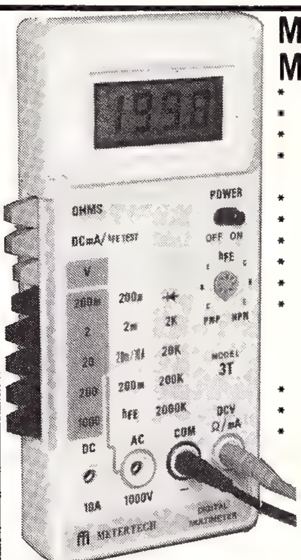

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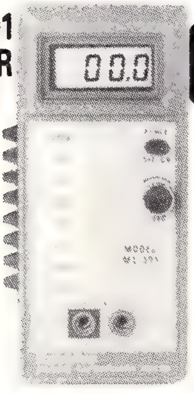

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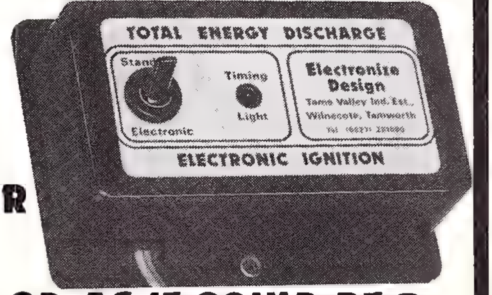

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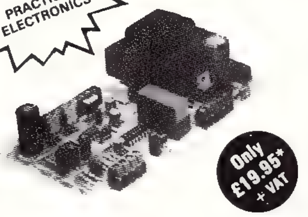

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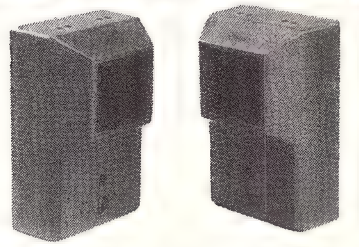

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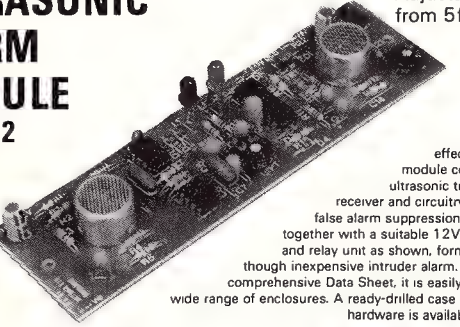

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WANTED, single trace oscilloscope, 15 MHz band width, minimum best offer paid. Hamid Reza Tajzadeh, 4th Floor, No 11, Street No. 3, Noarmack, Tehran 16479, Iran.

SONY TL 377 stereo open reel recorder £90, super speakers, Ditton 161" £60, Wharfdale Denton £25. Neal 4-channel adapt. £10. Mel Saunders, 7 Drumcliff Road, Thurnby Lodge, Leicester LE5 2LH.

YASHICA Electro 35 direct vision camera with telephoto + wide angle lenses, filter, hood, flash, tripod. New. All for £90. K.Y. Chang, 70, 1-up, Ashley St. Glasgow G3 6HW, Scotland.

Several test instruments for sale. Not recent models. Tel Wormley (Surrey) 4649.

WANTED, to make contact with Elektor readers for help in obtaining Elektor no 60 (April 80), price £3.50. Benderac Dragan, U1 Marijane Gregoran BR3, 11060 Beograd, Jugoslavija.

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JUNE '83

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8T28	120p
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8T96	90p
8T97	90p
8T98	90p
8035L	340p
8039L	290p
8080A	360p
8085A	450p
8155	450p
8212	155p
8216	100p
8224	160p
8226	195p
8228	250p
8251	300p
8253	450p
8255	280p
8257	450p
8259	450p
8279	450p
75107	90p
75108	90p
75110	88p
75112	160p
75182	95p
75450	85p
75451	50p
75452	50p
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29 37V	25p

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1 8432MHz	240p	6 880MHz	240p
2 0000MHz	225p	8.000MHz	160p
2 4576MHz	225p	10 000MHz	170p
3 0000MHz	240p	16 000MHz	190p
3 5795MHz	120p	18 432MHz	150p
3 6864MHz	240p	19 6608MHz	240p
4 000MHz	150p	20 000MHz	200p
4 1943MHz	190p	27 000MHz	170p
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EC911 0.189' Pads
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EC942 0 039'' Lines
EC943 0 049'' Lines
EC944 0 061'' Lines
EC945 0 079'' Lines
EC946 0 100'' Lines
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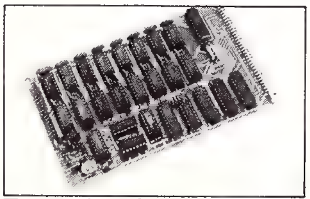
The Atom has 2K of RAM and 8K of ROM but of course this can be boosted enormously.

The computer has a full sized keyboard laid out in a conventional way. To use it just connect the power supply and a cable into the aerial socket of a TV set.

As well as integral sound output and direct cassette and TV interface, a wide range of additional interface boards are available to fit inside the casing. Extra 64K RAM, Colour, Printer, Laboratory, Cassette, 6522, 80x25 VDU, Analogue, Econet etc etc allowing the user to build a very sophisticated application machine. Full details of all accessories, disc pack, software etc are supplied with each machine.

The language used by the ATOM is BASIC, the language used by most personal computers.

The Atom's version is very fast, making it ideal for real time applications.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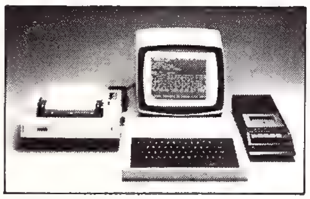
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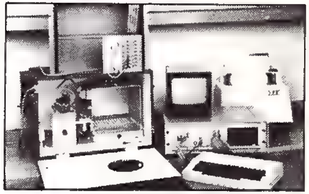
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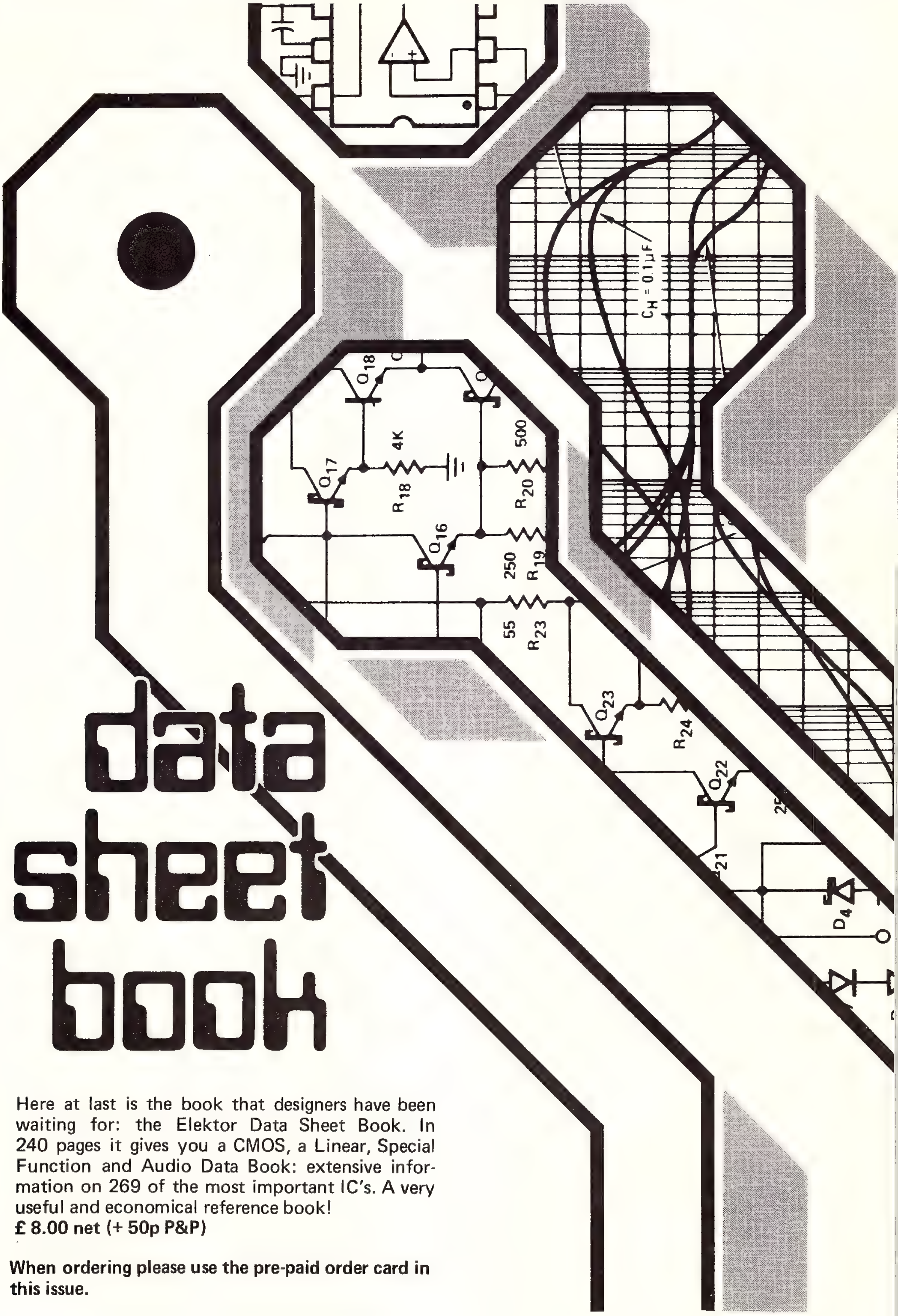

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Multifunction 3½-digit tester including transistor tester and 10A d.c. range. Over-range, low battery and polarity indication. Full fuse overload protection. Supplied complete with carrying case, test leads, battery and instruction manual.

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10A RANGE

d.c. Volts:-	0.2 – 2 – 20 – 200 – 1000V ± 0.8% Impedance 10M	Resistance:-	200 ohms – 2k – 20k – 200k – 2M – 20M ohms ± 1%
d.c. Amps:-	0.2mA – 2mA – 20mA – 200mA ± 1.2%; 10A ± 2%	Transistor check:-	h_{FE} 0 – 1000 PNP or NPN; I_{BE} 10uA, V_{CE} 2.8V.
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d.c. Volts:-	0.2 – 2 – 20 – 200 – 1000V ± 0.8%. Impedance 10M	Resistance:-	200 ohms – 2k – 20k – 200k ± 0.8% 2M ohms ± 2%
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Price per pair) 25 way	£ 2.00
37 way	£ 2.00
50 way	£ 2.50
Covers each	30p
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It should be noted however that only boards which have at some time been published in the EPS list are available; the fact that a design for a board is published in a particular article does not necessarily imply that it can be supplied by Elektor.

Technical queries

Please enclose a stamped, self-addressed envelope; readers outside UK please enclose an IRC instead of stamps.
Letters should be addressed to the department concerned — TQE (Technical Queries). Although we feel that this is an essential service to readers, we regret that certain restrictions are necessary:

1. Questions that are not related to articles published in Elektor cannot be answered.
2. Questions concerning the connection of Elektor designs to other units (e.g. existing equipment) cannot normally be answered. An answer can only be based on a comparison of our design specifications with those of the other equipment.
3. Questions about suppliers for components are usually answered on the basis of advertisements, and readers can usually check these themselves.
4. As far as possible, answers will be on standard reply forms.

We trust that our readers will understand the reasons for these restrictions. On the one hand we feel that all technical queries should be answered as quickly and completely as possible; on the other hand this must not lead to overloading of our technical staff as this could lead to blown fuses and reduced quality in future issues.

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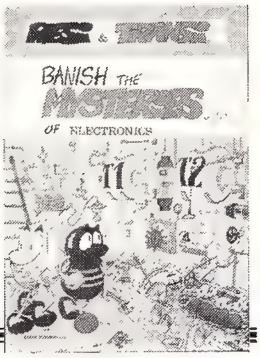

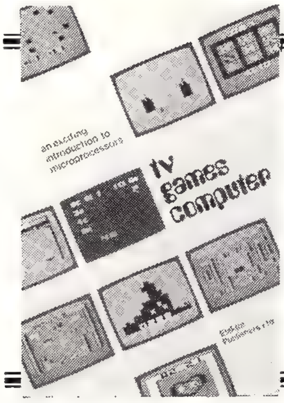

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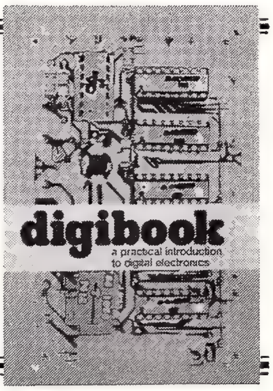

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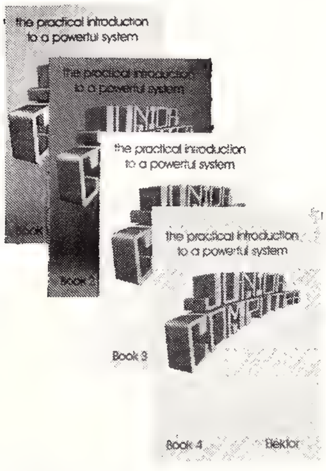

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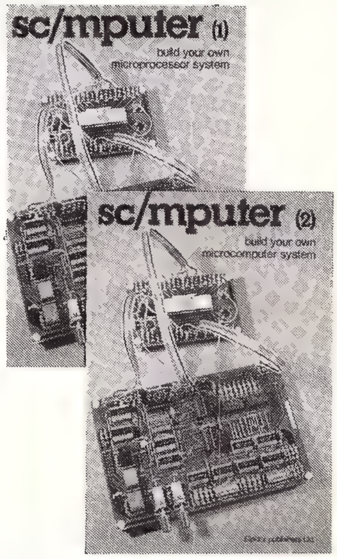
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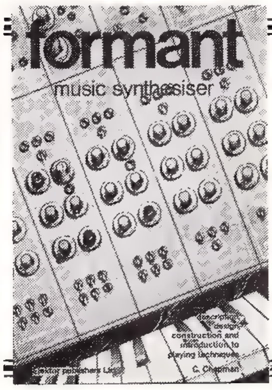
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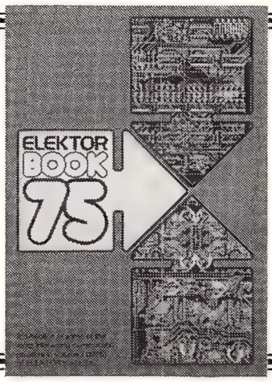

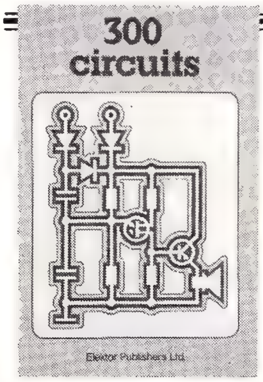

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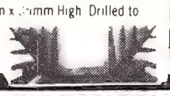

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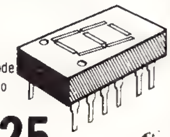

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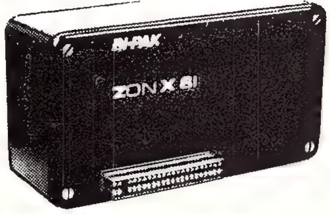

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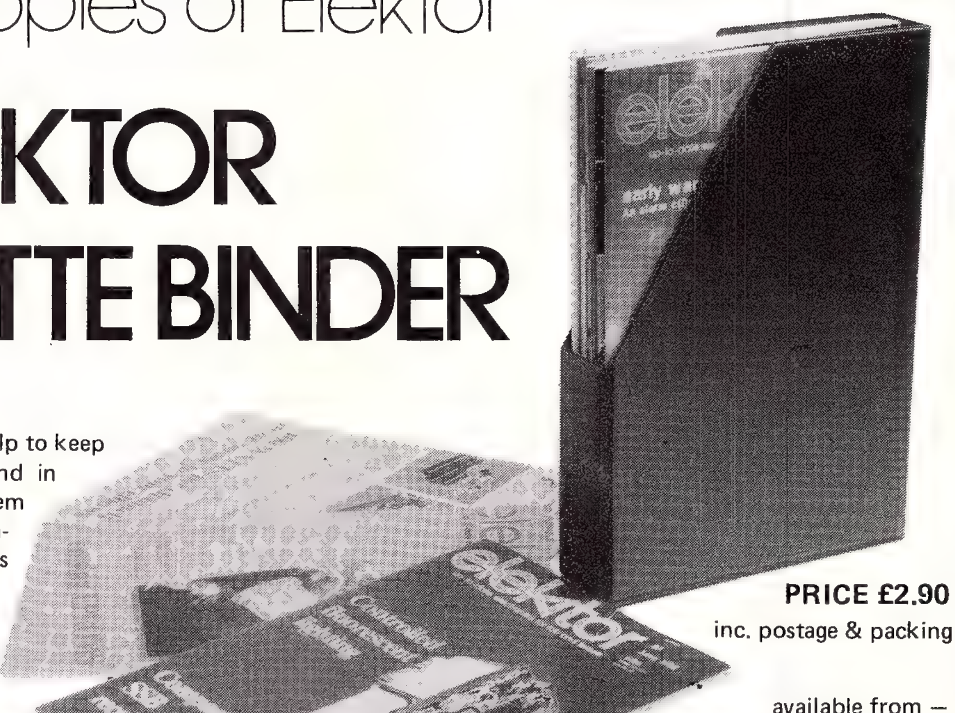

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Example:

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1	2	3	4	5

1. Circuit title
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3. board number

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		£	$
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E56: DECEMBER 1979			
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E58: FEBRUARY 1980			
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bus board 1	80068-1	6.40	12.75
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filter board	80068-3	4.30	8.50
input/output board	80068-4	4.—	8.—
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E61: MAY 1980			
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display board	80089-2	1.65	3.25
supply board	80089-3	3.80	7.50
E63/64: SUMMER CIRCUITS 1980			
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E65: SEPTEMBER 1980			
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E72: APRIL 1981			
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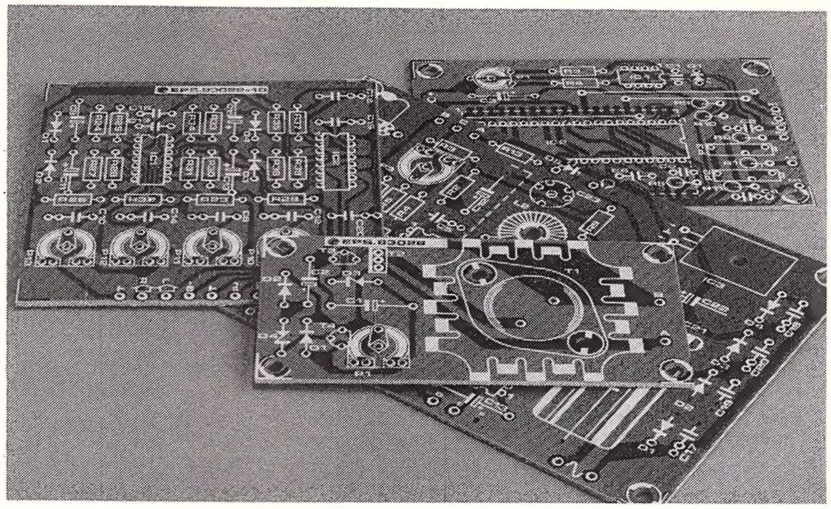

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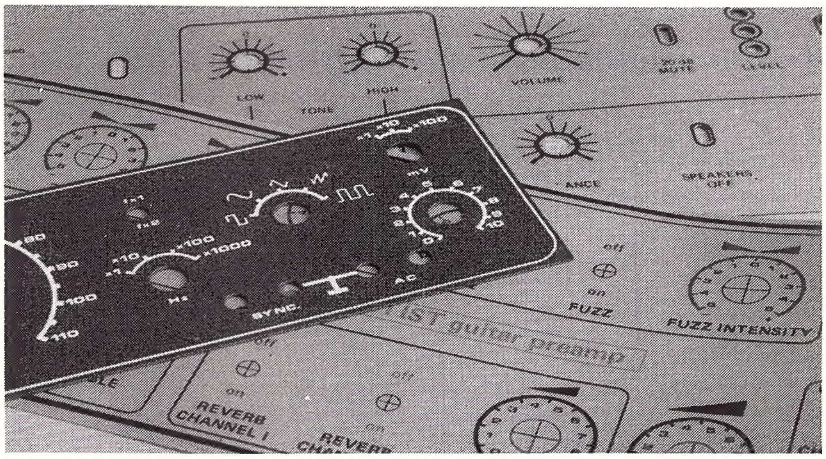

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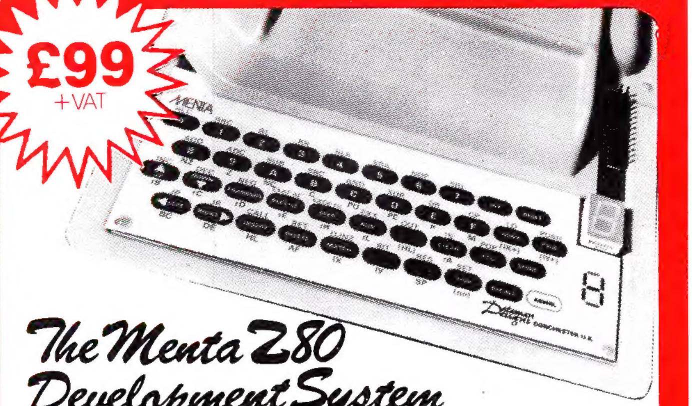

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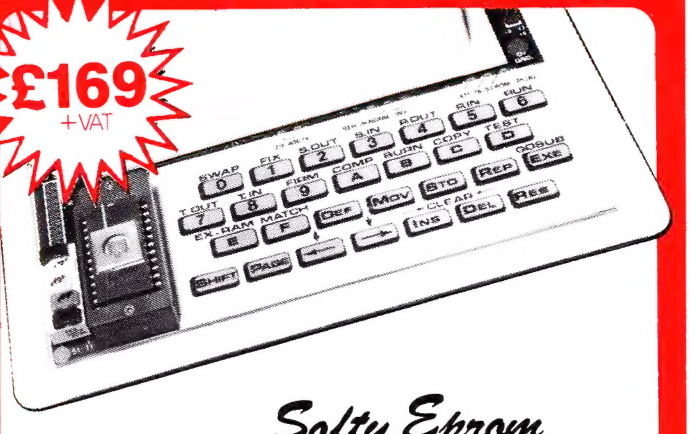

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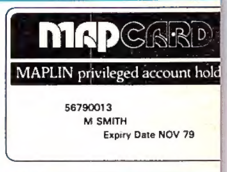
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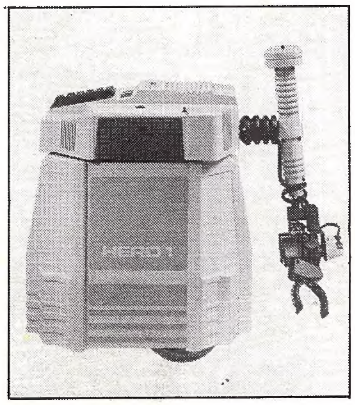

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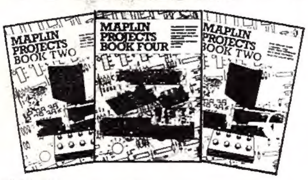

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